Annex D

Adaptive Management and Monitoring Plans for the Central Everglades Planning Project (CEPP)

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Introduction to Annex D: the CEPP Adaptive Management and Monitoring Plans

The CEPP PIR Annex D contains the adaptive management plan required by USACE implementation guidance for WRDA 2007 Section 2039[1], the 2003 Programmatic Regulations for the Comprehensive Everglades Restoration Plan and CERP Guidance Memorandum 56[2], and the monitoring plans required to address various laws, regulations, and permits necessary to implement CEPP. The items identified in this annex are based on knowledge formed from extensive scientific work on Everglades ecology and restoration, some initiated several decades ago, as well as USACE guidance and regulatory agency permit requirements. In particular the long-term, system-wide monitoring and modeling conducted by Comprehensive Everglades Restoration Plan's (CERP) interagency science group (the REstoration COordination and VERification group, or RECOVER) informed the planning of CEPP and the development of the adaptive management plan. *The overall objective of the adaptive management and monitoring plans in this annex is to: (1) identify the primary areas were restoration efforts will benefit from monitoring and assessment and specify the monitoring and assessment resources needed; (2) define how the monitoring and assessment can be used to refine CEPP implementation to improve restoration performance in the face of inevitable uncertainties, using existing knowledge complimented by CEPP's monitoring and assessment, and (3) meet regulatory and permit objectives to understand whether constraints are avoided and/or minimized.*

The monitoring plans contained in Annex D were guided in part by two objectives. First, they needed to be complete from a CEPP perspective by providing all monitoring required to address CEPP-specific needs. Second, they must be integrated with other Everglades monitoring to take advantage of existing monitoring efforts, knowledge, and information and thereby leverage dollars committed and spent elsewhere to avoid redundancies and insure cost-effectiveness. These two objectives have been accomplished in the adaptive management plan, hydrometeorological monitoring plan, water quality monitoring plan, and the ecological monitoring plan. It is expected that document reviews and future reassessments of CEPP monitoring needs will identify additional monitoring to address regulatory and consultation needs, as well as additional efficiencies that can be gained. Where possible, CEPP monitoring described here relies on existing monitoring resources including physical instrumentation, stations, locations, servicing, and analysis efforts funded by RECOVER, CERP sponsors, and partner agencies. Therefore the monitoring requirements described and budgeted in the CEPP monitoring plan are limited to the additional, marginal increase in monitoring resources and analysis efforts needed to address CEPP-specific questions. The CEPP monitoring plan relies on other monitoring in order to keep its monitoring costs to a minimum and assumes these other monitoring efforts will continue at least for the period required by CEPP. A table and diagram of leveraged monitoring is provided in the implementation section of Part 1, the Adaptive Management Plan.

Part 1: Adaptive Management Plan – The first section, the Adaptive Management Plan (Annex D, Part 1), provides the strategies to address prioritized project uncertainties that will be faced as CEPP progresses toward achieving restoration goals and objectives while remaining within constraints. Each strategy follows a scientific approach that uses performance measures, monitoring, triggers and/or thresholds to inform restoration progress and support decisions regarding the need to adjust CEPP to

[1] USACE, 2009. USACE HQ Implementation Guidance on Section 2039 of Water Resources Development Act. http://cw-environment.usace.army.mil/pdfs/09sep2-wrda-monitor.pdf

[2] USACE and SFWMD 2011. CERP Guidance Memorandum 56: Integration of Adaptive Management into Program and Project Management. http://www.cerpzone.org/documents/cgm/CGM_56_Adaptive_Management.pdf

improve restoration performance. Suggestions for informing future increments of CERP that were discussed by the adaptive management team during the development of the CEPP Adaptive Management Plan have been included, but demarcated to show that they are not expected to be authorized as part of the CEPP Plan. Rather, these are described here to ensure the best current understanding of needs that may be considered in the future to further improve restoration. These suggestions are summarized in the CEPP PIR Section 6.10.1, Incremental Restoration and Future Opportunities. The management options included in this adaptive management plan can be described as the following:

1. *Informing CEPP Implementation* - results of monitoring a project component inform next phase of project component construction sequencing,
2. *Inform Project Operations* - results inform project operations or system operating manuals,
3. *CEPP Adaptive Management Contingency Options* - results inform potential additional restoration actions.

A management option matrix is then provided to link monitoring, triggers and thresholds, and management options in order to inform decision-makers, CEPP partner agencies, and the public on potential actions to improve restoration performance. The monitoring identified in this plan is considered part of the adaptive management strategies, as per the 2003 Programmatic Regulations for the Comprehensive Everglades Restoration Plan, CGM 56, and the USACE CERP Adaptive Management Integration Guide (RECOVER 2011b), in accordance with WRDA 2007 and its subsequent implementation guidance. The monitoring is specific to uncertainties raised during CEPP planning which require refined data to address, and which will inform feasible options to adjust CEPP as identified in the CEPP Adaptive Management Plan. Per USACE planning guidance ER-1105-2-100 Appendix E, the intent of focusing on the uncertainties is to address questions and reduce the uncertainties. For CEPP in particular, doing so helps to ensure that CEPP water infrastructure investments continue to be good investments over the long time span of the project, potentially avoids expending funds if detailed data collection shows possible reductions in construction needs, and helps to avoid exceeding Section 902 cost increases by incorporating the best new knowledge into design, construction, and operations.

It should be noted that the adjustments and options identified in this adaptive management plan are part of the recommended plan, except where noted, and those few exceptions are demarcated as suggestions that may apply to future restoration projects. All requirements to obtain authorization to implement those suggestions, and the required agency coordination, would apply. The suggestions are provided to capture the best current understanding of measures that may be needed to achieve Everglades restoration beyond CEPP, with recognition that CEPP provides a significant increment but not complete restoration.

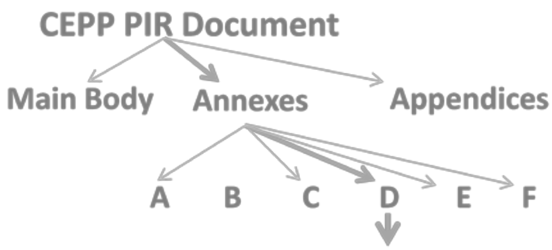
Part 2: Hydrometeorological Monitoring – Contains the necessary monitoring to ensure CEPP implementation complies with all applicable State water quality standards.

Part 3: Water Quality Monitoring Plan – Identifies the necessary hydrologic and meterologic monitoring needed to operate CEPP project structures.

Part 4: Ecological Monitoring Plan – The primary purpose of the CEPP Ecological Monitoring Plan is to identify the monitoring necessary to inform decision-makers, CEPP partner agencies, and the public on CEPP's achievement of its project objectives, i.e. its achievement of success. This monitoring will be leveraged as much as possible to contribute to CEPP adaptive management. However, given the scope and scale of CEPP, the ecological monitoring and the monitoring identified in the adaptive management plan are not one-and-the-same because the ecological monitoring plan focuses on CEPP's success at meeting project objectives (per WRDA 2007 guidance) while the monitoring specified in the adaptive management plan focuses on addressing project uncertainties (per WRDA 2007 and subsequent guidance) that may be more specific in their location and/or scale than the overall project objectives. Also, the adaptive management plan focuses on project adjustments that could be made relatively easily to improve project performance, and the monitoring described in that plan will inform such adjustments. Whereas monitoring for overall project success for a project as large as CEPP may not provide the level of detail needed to answer the specific adaptive management questions to inform location-specific adjustments. In summary, since the project objectives and the uncertainties are not redundant then neither is the monitoring, but the plans have been designed to work together and inform each other as much as possible and it is encouraged that any future refinements of these plans include continual improvements of the streamlining between plans.

The ecological monitoring plan will also contain the monitoring required under the U.S. Fish and Wildlife Biological opinion and other agency permits required to protect and conserve natural resources.

The Quality Assurance Systems Requirements (QASR) (SFWMD and USACE, 2009) manual will be followed to ensure all monitoring data collected adheres to appropriate quality assurance and control standards for CERP. All of the plans in this annex are based on CEPP goals, objectives, and constraints, described in Section 1.3.1 of the CEPP PIR document. **Figure D.1.1** below is intended to help readers navigate the parts of the CEPP Adaptive Management and Monitoring Plan Annex. The parts are 'linked' in that monitoring specified in Parts 2-4 may be referred to and used for CEPP's adaptive management. It may be possible to improve the linkages; therefore it is suggested that any future refinements of CEPP monitoring should continually seek to further coordinate with multiple monitoring plans and programs. The plans will support achievement of CERP and CEPP goals and objectives and remain within constraints by providing the data necessary to detect changes expected due to CEPP.



Annex D: Monitoring and Adaptive Management Plan.

Introduction

Part 1: Adaptive Management Plan (AM Plan). Will include AM-relevant uncertainties, strategies, and management options. **Will refer to other monitoring where possible.**

Part 2: Hydrometeorological Monitoring

Part 3: Water Quality Monitoring

Part 4: Ecological Monitoring

Annex G: Invasive and Nuisance Species Management Plan

Figure D.1.1: Organization of Annex D.
This figure is intended to help readers navigate the four parts of the CEPP Adaptive Management and Monitoring Plan Annex. The parts are 'linked' in that monitoring specified in Parts 2-4 and in the Invasive and Nuisance Species Management Plan may be referred to and used in the Adaptive Management Plan.

The cost estimates for each monitoring plan are $24,350,000 (adaptive management); $5,976,000 (water quality monitoring estimate); $11,483,750 (hydrometeorological monitoring); $8,250,000 (ecological monitoring, and USFWS Biological Opinion monitoring will be added). In addition, an estimate of $16,500,000 is provided to cover several adaptive management options. The total estimated cost of CEPP monitoring is $66,584,750 plus the amount that will be added for USFWS Biological Opinion monitoring. These costs are paid by CEPP during different phases of the project, as shown in Table D.1.1 below.

Table D.1.1: Summary of Annex D Adaptive Management and Monitoring Costs.
This summary shows the monitoring associated with chronological phases of the CEPP project, per monitoring plan. The adaptive management options are a potential project cost associated with improvement of the project based on knowledge gained from monitoring and analysis. Adaptive management options may or may not be implemented, as needed. Due to the large scale and complexity of CEPP the annual cost of the adaptive management monitoring shown here occurs in 10-yr windows coordinated with implementation phases of CEPP, over a total of 23 years, as shown in Figure D.1.2. In the annual cost column, the ecological monitoring assumes a worst case cost scenario in which all ecological monitoring takes place in one 10-yr window, however it is expected that the ecological monitoring could be implemented in 'rolling windows' coordinated with CEPP implementation as the adaptive management monitoring will be.

	Pre-Construction Engineering and Design/Construction	Operational Testing & Monitoring Phase	Post-construction Monitoring (10-yr windows)	50 Year OMRRR	Total	Annual
Adaptive Management Plan	4,845,000	-	19,530,000	-	24,375,000	1,953,000
Adaptive Management Options	16,500,000	-	-	-	16,500,000*	330,000
Water Quality	17,000	133,000	5,826,000		5,976,000	649,200
Hydrometeorological	-	1,706,000	-	9,777,750	11,483,750	229,675
Ecological	825,000 + USFWS BO	TBD (USFWS BO)	7,425,000	TBD (USFWS BO)	8,250,000 + USFWS BO	825,000** +BO
TOTAL	5,687,000 + BO	1,839,000 + BO	32,781,000	26,277,750 + BO	66,584,750 + BO	3,986,875 + BO

ANNEX D

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Part 1. CEPP Adaptive Management Plan

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1.0 CEPP ADAPTIVE MANAGEMENT PLAN EXECUTIVE SUMMARY

CEPP's planning and tentatively selected plan (TSP) were based on the extensive existing scientific knowledge of the Everglades and associated estuaries, understanding of the problems and opportunities, and the evaluation of alternatives and estimation of the potential project restoration performance. While the CEPP PIR is based on this wealth of knowledge, this adaptive management plan is provided to help address uncertainty that exists as in every natural resource management and restoration effort. Several sources of agency guidance exist regarding such uncertainties, including the U.S. Army Corps of Engineers ER-1105-2-100 Section 3-5 and Appendix E, WRDA 2007 Section 2039 and its implementation guidance, the 2003 Programmatic Regulations for the Comprehensive Everglades Restoration Plan, and its subsequent guidance including CERP Guidance Memorandum 56 (CGM 56) and the Adaptive Management Integration Guide (RECOVER 2011b). Per these sources, the concerns and uncertainties of coordinating agencies and stakeholders were taken into consideration throughout CEPP planning. The uncertainties were addressed by several means that are part of the USACE planning process, and some that could not be fully resolved during planning are described in this adaptive management plan. This plan specifies strategies and appropriate timing to address the uncertainties.

The adaptive management plan provides a screened and prioritized summary of specific uncertainties that can be addressed with efficiently structured approaches. The adaptive management plan describes the approaches, called strategies, and management options suggested for future consideration if needed. The adaptive management plan is a culmination of input from well-developed USACE planning procedures, extensive scientific and local knowledge that has developed over decades of experience, and input from the CEPP PDT during planning and the CEPP Value Engineering and Cost Risk Analysis workshop.

Every CEPP uncertainty in the adaptive management plan was screened with criteria described in Section 1.3 of this document to ensure their applicability to CEPP and to adaptive management as it is described in the 2003 Programmatic Regulations for the Comprehensive Everglades Restoration Plan and its subsequent CERP guidance. The screening criteria were based on CGM 56 and criteria provided in the CERP Adaptive Management Integration Guide (RECOVER 2011b). Each uncertainty needed to: (1) potentially affect CEPP's ability to meet its goals and objectives and remain within its constraints; (2) be at an appropriate CEPP-scale spatially and temporally; (3) have options for adaptive management actions such as potential project adjustments; and (4) have a combination of high importance to CEPP and high uncertainty that could be reduced by practical adaptive management means. As a result of the screening, some topics were routed to more appropriate venues for consideration, such as CEPP's operation plan, the work plan for CERP's interagency system-wide science group (RECOVER), and/or the interagency modeling group that supports CERP.

The screened uncertainties were then considered by six subteams who provided strategies and options for addressing them. Suggestions for informing future increments of CERP that were discussed by the adaptive management team during the development of the CEPP adaptive management plan have been included, but demarcated to show that they are not expected to be authorized as part of the CEPP Plan. Rather, these are described here to ensure the best current understanding of needs that may be considered in the future to further improve restoration. These suggestions are summarized in the CEPP PIR Section 6.10.1, Incremental Restoration and Future Opportunities. The management options included in this adaptive management plan can be described as the following:

1. *Informing CEPP Implementation* - results of monitoring a project component inform next phase of project component construction sequencing,

2. *Inform Project Operations* - results inform operational changes related to the project contained within the project or system operating manuals,

3. *CEPP Adaptive Management Contingency Options* - results inform the need to take additional restoration actions that are contingent on agencies concurring on their need to achieve restoration benefits.

The strategies and management options comprise the bulk of this adaptive management plan. The adaptive management plan describes how adaptive management will be incorporated in the next steps of CEPP, e.g., scheduling, design, construction, and throughout the life of CEPP (CGM 56, RECOVER 2011b).

Adaptive management activities will be implemented during the coming phases of CEPP, and the adaptive management plan will be updated accordingly. At such time, more baseline data and lessons learned will be available from other monitoring programs and restoration projects. Given the new knowledge and answers to key questions the adaptive management strategies and options proposed in this Plan may need refinement. Therefore, items included in this plan are not guaranteed to be funded as-is, but will be considered again when CEPP is closer to being implemented and funding decisions will be made commensurate with available funding at that time.

1.1 CEPP Adaptive Management Plan Introduction

CEPP's planning and tentatively selected plan were based extensively on scientific knowledge of the Everglades ecosystem and associated estuaries, from understanding the problems and opportunities to evaluating alternatives and estimating potential project restoration performance (Davis and Ogden 1994; Department of Defense 2003; RECOVER 2004; Ogden 2005; RECOVER 2009; McVoy, et al. 2011; and RECOVER 2011a; CEPP PIR Appendix H) and U.S. Army Corps of Engineers and CERP guidance. However, uncertainty exists in every natural resource management and restoration effort due to the fact that many processes in the ecosystem are not linear, they work synergistically together, and they will unfold in a future climate that is likely different than the one used to formulate the CEPP plan. The CEPP Adaptive Management Plan will address the key uncertainties identified during CEPP's planning that relate to achieving restoration success and making adjustments of CEPP implementation, if determined to be necessary to improve performance.

Congress understood that there were uncertainties in the Comprehensive Everglades Restoration Plan and therefore required CERP to include adaptive management for its individual projects (WRDA 2000). The 2003 programmatic regulations (Pro Regs) outlined an adaptive management program that would provide the tools needed to gather new information from the RECOVER monitoring and assessment plan (MAP- RECOVER 2009) and incorporate these so that CERP could be adjusted to ensure restoration success. The National Research Council's Committee on the Independent Scientific Review of Everglades Restoration Progress (CISRERP) endorsed the CERP adaptive management program (NRC 2007) and concluded that "uncertainties remain about the degree to which a resilient, self-sustaining ecosystem can be restored under the dramatically changed environment of South Florida" (NRC 2008). The CISRERP noted that adaptive management is essential for "…designing management strategies for dealing with complex ecosystem projects for which probable ecosystem responses are poorly known and hence, difficult to predict" (NRC 2007). The CISRERP further reinforced its view regarding the essentialness of adaptive management in CERP project planning and implementation by stating that, "Given the enormous scope and complexity of the restoration effort, the success of the CERP depends on strategic, high-quality, responsive, and sustained science and an effective adaptive management framework" (NRC 2010).

Per the 2003 Pro Regs, CERP produced guidance for project teams to develop adaptive management plans and integrate adaptive management activities into all phases of a project lifecycle, e.g., planning, design, construction, and operations (USACE and SFWMD, 2011; RECOVER, 2011b). These are appropriate to the large scale and complexity of CERP and its projects, with its changing context of new non-CERP water infrastructure projects, and the shifting nature of its ecosystems. The intent of the detailed guidance is to improve restoration performance and reduce costs by increasing certainty throughout project implementation. The CERP guidance is consistent with the Everglades adaptive management WRDA 2000 authorization, as well as follows the more general 2009 adaptive management guidance from U.S. Army Corps of Engineers (USACE) Headquarters on implementing Section 2039 of WRDA 2007.

In summary, there is extensive knowledge about the Everglades and there are uncertainties that arise during project planning that need to be addressed. Rather than delaying planning for the sake of further data collection or model development, the adaptive management plan provides a mechanism to systematically address uncertainties during CEPP's implementation in order to confirm that project performance is on the right trajectory, to detect early if an adjustment is needed, and to provide sound data to inform operations and implementation decisions. The adaptive management plan identifies which areas to monitor to detect performance, and options for adjusting CEPP if needed to remain on track with performance expectations, as well as suggesting future CERP options to meet overall CERP restoration goals. The suggestions for future CERP options are not expected to be authorized as part of the CEPP Plan. Rather, these are described to capture the best current understanding of needs that may be considered in the future to further improve restoration beyond CEPP. These suggestions are summarized in the CEPP PIR Section 6.10.1, Incremental Restoration and Future Opportunities.

Definitions that will help the reader in understanding the CEPP Adaptive Management Plan include the following. Additional definitions, specific to the adaptive management strategies that make up the bulk of this adaptive management plan, can be found in **Table D.1.2 CEPP Adaptive Management Uncertainties and Strategies Template and Definitions.** The concepts and definitions are described in more detail in CGM 56 (2010) and in the CERP Adaptive Management Integration Guide (RECOVER 2011b).

- **Adaptive Management** – A scientific process for continually improving management policies and practices by learning from their outcomes; Adaptive Management links science to decision making to improve restoration performance, efficiency, and probability of success. In the context of Everglades restoration, adaptive management is a structured approach for addressing uncertainties by testing hypotheses about the best project designs and operations to achieve restoration goals and objectives, linking science to decision making, and adjusting implementation, as necessary, to improve the probability of restoration success.
- **Uncertainty** – A question faced during planning or implementation regarding the best actions to achieve desired goals and objectives within constraints, which cannot be fully answered with available data or modeling.
- **Management Options** – Potential structural, non-structural, and operational alternatives to be undertaken to improve restoration performance. In the CERP planning process, management actions are grouped into alternative plans. Adaptive management plans contain potential management actions "options" that may be taken to improve performance if project/program goals and objectives are not met.
- **Strategies** – A plan to address one or more uncertainties identified in the adaptive management Plan. The adaptive management strategies fit into the following approaches:
    - *Active Adaptive Management* (See **Figure D.1.3**) – Multiple pilot projects or design tests are implemented to test designs or operational criteria to achieve desired goals and objectives. Each design or operational action is monitored, assessed, and results are used to inform implementation of the best design for a CEPP project component or operations. Pilot projects or design tests are usually conducted before implementing the full project component that they are intended to inform.

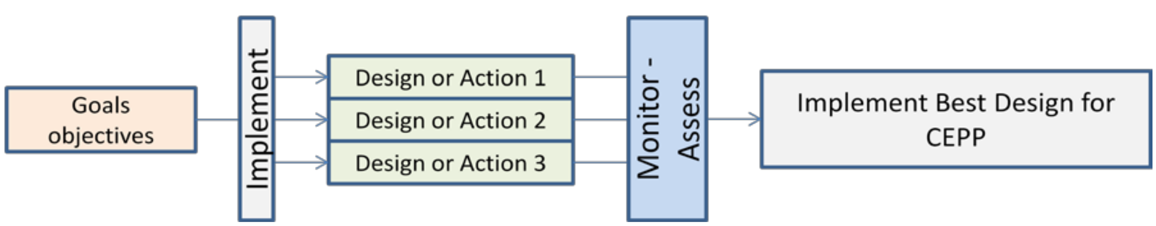


Figure D.1.3: Active Adaptive Management.

Project goals and objectives are evaluated to determine multiple designs or management actions to test by implementing them with associated monitoring, assessing results, and determining the best design of a particular CEPP component to move forward.

- o *Passive Adaptive Management* (see **Figure D.1.4**) – Most of the CEPP adaptive management Plan strategies are considered passive adaptive management approaches. One project component or set of operational criteria is implemented to test its ability to achieve desired goals and objectives. Results are monitored, assessed, and communicated to implementing agencies and the appropriate participating agencies to determine how best to adjust project component designs, operations, CEPP contingency options, or inform future CERP projects.

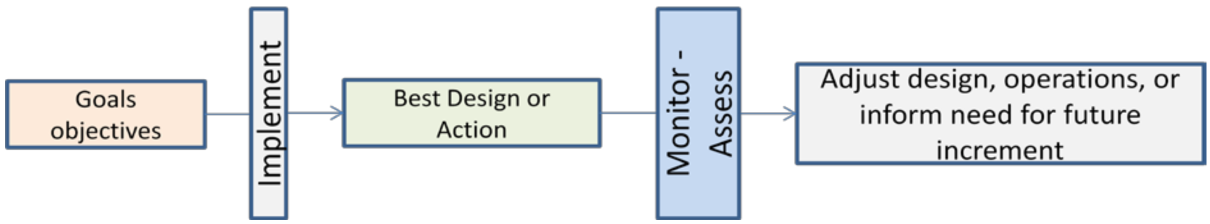


Figure D.1.4: Passive Adaptive Management.
Diagram illustrates that the best design or management action is implemented to achieve project goals and objectives with associated monitoring and results are assessed to adjust other CEPP project component designs, adjust operations, and inform the need for a future CERP increment.

The CEPP adaptive management monitoring recommended as part of the adaptive management strategies is specific to monitoring to address uncertainty and where there are options to adjust CEPP implementation, as described in the introduction to this Annex and this Plan. The adaptive management team first reviewed existing monitoring funded by RECOVER, other agencies, and required for CEPP to undertake for other project purposes, e.g., operating new structures, compliance with water quality permits or biological opinions. The monitoring recommended in this adaptive management plan is what is needed beyond the other sources to address key CEPP uncertainties identified during planning.

Adaptive management activities will be implemented during the coming phases of CEPP, and the adaptive management plan will be updated accordingly. At such time, more baseline data and lessons learned will be available from other monitoring programs and restoration projects. Given the new knowledge and answers to key questions the adaptive management options proposed in this Plan may need refinement. Therefore, items included in this plan are not guaranteed to be funded as-is, but will be considered again when CEPP is closer to being implemented and funding decisions will be made commensurate with available funding at that time.

1.2 How the CEPP Adaptive Management Plan was Developed: Identification, Screening, and Prioritization of CEPP Uncertainties

The CEPP Adaptive Management plan process consisted of the following activities, consistent with the USACE planning guidance and CERP adaptive management guidance:

- Stakeholder involvement to identify new information during the development of the adaptive management plan;

- USACE planning and adaptive management principles were applied in the planning and screening of project features that were used to create several alternative plans and the TSP in order to increase confidence that CEPP's components would have sufficient flexibility to continue to be good investments in a shifting environment (Section 1.5.5 of this adaptive management plan);
- Identification and prioritization of key CEPP adaptive management uncertainties, also referred to simply as "uncertainties" throughout this Plan (Section 1.3 of this adaptive management plan) related to achieving CEPP goals and objectives and avoiding constraints (Section 1 of PIR);
- Development of adaptive management strategies to address the uncertainties during CEPP design, construction, and operations that consider existing Everglades conceptual ecological models, hypotheses, performance measures, and monitoring (Section 1.3 of this adaptive management plan);
- Identification of monitoring thresholds and/or triggers and associated management options to adjust, if necessary, based on feedback from assessments (Section 1.3 of this adaptive management plan);
- Adaptive management implementation process to carryout adaptive management activities during design, construction, operations related to baseline and post-project construction monitoring, tests, analyses, and the process for communicating scientific findings to decision-makers, restoration partners, and the public (Section 1.5 of this adaptive management plan).

The identification of CEPP uncertainties to be considered for inclusion in the CEPP Adaptive Management Plan began with input from the CEPP PDT, uncertainties already identified in the Decompartmentalization and Sheetflow Enhancement of Water Conservation Area 3 project ("Decomp") documentation report (USACE and SFWMD, 2012), and the prioritized list of CERP scientific restoration uncertainties identified by RECOVER in 2011. The outcome of this early effort, along with uncertainties identified through a multi-agency PDT process, produced a large list of CEPP-related uncertainties to be considered for inclusion in the CEPP Adaptive Management Plan.

The large list of uncertainties was screened using the following criteria:

1. Must be directly related to CEPP goals, objectives, or 'constraints'. The constraints included but were not limited to the legal/USACE definition of constraints; they also included important considerations identified during CEPP PDT and planning discussions.
2. Must be at project-scale. Although CEPP is large, it is not system-wide scale. System-wide uncertainties were routed to appropriate groups.
3. Must have adaptive management options, i.e., ability to be addressed during implementation, improved by adjusting CEPP, or addressed by a future increment of restoration.
4. Must be an uncertainty. Don't include items that are already known. For example, don't ask "What are the effects of reduced fresh water discharges on oysters in the northern estuaries?" which is known. Instead ask, "Will CEPP's reduction of fresh water peak discharges in the northern estuaries improve salinity conditions enough to significantly improve conditions for oysters?"
5. The uncertainty needs at least one attribute that is measurable that will provide information to resolve the uncertainty, i.e. the attribute must be a trait able to change in the timeframe of the Adaptive Management Plan, and one that is distinct from the 'background noise' of natural variability. Long-term changes may need a surrogate measure for the adaptive management Plan.

6. Some items remained on the uncertainties list to "Keep them in view", e.g., uncertainty about CEPP effects on Lake Okeechobee's littoral zone, and the balance needed between the ecological needs of the Lake and the northern estuaries should be kept in view until reconciliation is developed for the uncertainty. E.g., effects of flow in Shark River Slough on peat dynamics, which is important but hard to link to management options. E.g., potential for CEPP to cause hydrologic changes in the Pennsuco wetlands east of the project area.

Once a short-list of screened uncertainties was identified, the following criteria were used to prioritize them:

Risk: What is the risk (high, medium, low) of not meeting CEPP restoration goals if this uncertainty is not addressed?

- Low risk means that even if the uncertainty isn't addressed, it doesn't pose much risk to achieving CEPP goals and objectives.
- Medium risk means that if the uncertainty isn't addressed it may or may not affect achievement of a goal/objective.
- High risk means that without addressing this uncertainty, there is a high risk to achieve CEPP goals and objectives.

Knowledge: What is the level of (high, medium, low) understanding of this uncertainty (i.e., how much is known about this uncertainty)?

- Low understanding means little is known about the question/issue or how to address it;
- Medium understanding means some information is known in some geographical areas, but not all;
- High understanding means a lot is known about addressing this question in multiple geographical areas.

Relevance to Adaptive Management for CEPP: What is the level of confidence (high, medium, low) that anything could be done to address the uncertainty? The team's preliminary identification of management options helped to determine this.

- Low confidence means that even if this uncertainty is addressed, CEPP or operations will not be able to be modified given the results of CEPP implementation.
- Medium confidence means if this question is addressed, a connection to future CERP project implementation is established/documented but future adjustments to the CEPP increment 1 may or may not be limited, especially if indicator response is longer than 10 years and is more relevant to RECOVER system-wide monitoring.
- High confidence means if this question is addressed, CEPP design, implementation, and/or operations can be modified to improve restoration results.

The identification, screening, and prioritization process resulted in a final prioritized list of uncertainties. This list was used to develop strategies, management options, and costs in order to develop the adaptive management Plan.

1.3 CEPP Adaptive Management Uncertainties, Strategies, and Management Options

The CEPP uncertainties in this section target prioritized needs and opportunities to learn in order to make scientifically sound recommendations to refine CEPP design, construction, and operations; the strategies and management options provided to address each uncertainty are intended to guide CEPP performance in the face of inevitable uncertainties, with existing knowledge and knowledge that will be gained through monitoring and assessment. The strategies are focused on CEPP, but designed to contribute to future increments of CERP restoration as well in order to maximize 'return on investment' for resources invested in pursuing the adaptive management activities. Suggestions of future increments of CERP that may be useful are the best current understanding of needs that may be considered in the future to further improve restoration beyond CEPP, and are not intended to be authorized as part of the CEPP Plan. These suggestions are summarized in the CEPP PIR Section 6.10.1, Incremental Restoration and Future Opportunities. As with the other monitoring plans in Annex D, the monitoring proposed in the adaptive management strategies was guided in part by two objectives: to be complete from a CEPP perspective by providing the monitoring required to address CEPP-specific uncertainties; and to integrate with other Everglades monitoring to take advantage of existing monitoring efforts, knowledge, and information and thereby leverage dollars committed and spent elsewhere to avoid redundancies and insure cost-effectiveness. *Where possible, the CEPP adaptive management strategies rely on existing monitoring resources such as physical instrumentation, stations, locations, servicing, and analysis efforts funded by RECOVER, CERP sponsors, and partner agencies. Therefore the monitoring requirements described here are limited to the additional, marginal increase in monitoring resources and analysis efforts needed to address CEPP-specific adaptive management questions.* This point is discussed in the CEPP Adaptive Management Implementation section of this plan, and a table is provided to show leveraged monitoring. In addition, it should be noted that the timing of the strategies is staggered throughout the design and implementation of CEPP. Please see Section 1.5 Implementation of CEPP Adaptive Management and associated figures for more detail on the estimated start- and stop-times for each adaptive management strategy.

The uncertainties, their strategies, and management options are organized in this Plan by geographic region: CEPP-wide, Lake Okeechobee/Northern Estuaries, Greater Everglades, Southern Coastal Systems, and Lower East Coast.

The uncertainties, their identification numbers (ID#), and the CEPP project objective and/or constraint are listed here for reference. The project objectives and constraints are described in detail in CEPP PIR **Section 1** (**Introduction**). A list of uncertainties that were screened out is provided in the final section of this adaptive management Plan to show the suite of ideas that were considered and brief notes from the screening process. As the CEPP Project Team learns from CEPP implementation the list of CEPP adaptive management uncertainties will be updated to identify which have been addressed and where the risks to achieving CEPP restoration success have been lowered. The remainder of this section of the adaptive management Plan provides strategies for addressing these uncertainties:

CEPP-wide

- How will CEPP influence the introduction and growth of non-native invasive and native nuisance species populations within the project area, and will the species influence the predicted landscape and performance of CEPP? (ID#59/66; CEPP Objective 1)

Lake Okeechobee

- Do CEPP's operational refinements for Lake Okeechobee, which are projected to keep lake stage within LORS 2008 regulation schedule and which reduce the duration and number of high volume fresh water discharge events for the northern estuaries, affect the Lake Okeechobee littoral and nearshore vegetation coverage? (ID#3, CEPP Objective 3)

Flow Equalization Basin (A-2 FEB)

- How can we most effectively learn from the FEB-1 to integrate FEB-1 and the A-2 FEB and to optimize their operations to maximize flows to the Everglades via the FEBs while balancing the related needs of Lake Okeechobee and the northern Everglades? (ID#4; CEPP Objectives 1, 2, 5, and Constraints related to water quality)

Northern Estuaries

- St. Lucie Estuary
  - Do reductions of high volume fresh water discharges (high flows) result in measurable increases in submerged aquatic vegetation (SAV) coverage in St. Lucie Estuary (SLE)? (ID#1; CEPP Objective 3)
  - To what extent will the reduction in the frequency and magnitude of high flows to the SLE stabilize conditions enough to improve benthic habitat in the SLE in the south fork? (ID#46; CEPP Objectives 4, 5)
  - To what extent will the reduction in the frequency and magnitude of high flows to the SLE help reestablish historic oyster beds on the South Fork SLE? (ID#45; CEPP Objectives 3, 5)
- Caloosahatchee Estuary
  - Do reductions of high volume fresh water discharges result in measurable increases in SAV coverage and oyster acreage and health in the Caloosahatchee estuary? (ID#2; CEPP Objective 3)
  - Will the reduction in low flow violations in the Caloosahatchee estuary help re-establish persistent *Vallisneria* beds in the upper Caloosahatchee estuary? (ID#49; CEPP Objectives 4, 5)

Greater Everglades

- Are the flow velocities, flow direction, volumes of fresh water, and water depth improvements from CEPP sufficient to reestablish historic ridge and slough landscapes? (ID#73; CEPP Objectives 1, 2, 5)
- Can CEPP create hydrology favorable for tree island elevation requirements? (ID#76; CEPP Objectives 1, 2, 5)
- Are inundation and hydroperiod sufficient to reduce current high rates of soil oxidation and peat fires? (ID#5; CEPP Objective 2)
- How much will CEPP improve alligator relative density and body condition in northern WCA 3A, WCA 3B and northeast Shark River Slough (NESRS)? (ID#10; CEPP Objectives 4, 5)
- How much will hydrologic restoration and vegetation management result in increases in prey densities (aquatic fauna)? (ID#9; CEPP Objective 1)
- How much will hydrologic restoration and vegetation management result in increases in wading bird foraging conditions and increased nest number and success of Wood Storks and Roseate Spoonbills? (ID#75; CEPP Objective 1)

Greater Everglades/ Lower East Coast

- Will full suite of CEPP TSP structures be required in WCA 3B to create the Blue Shanty Flowway? (ID#77; CEPP Objectives 1,2,4,5 and Constraints related to water supply, flood risk management, and water quality)

Everglades National Park (ENP)/ Southern Coastal Systems

- Will there be downstream biogeochemical effects associated with modifying inflows and hydrologic conditions in ENP, including effects on nutrient movement, availability, and ecological responses? This includes consideration of hydrologic effects on nutrient loading, nutrient release from soils, transport, and water-quality related ecological indicators, such as periphyton tissue nutrients, cattail expansion, and algal bloom events, especially in eastern Florida Bay where nitrogen levels are relatively high? (ID#63; CEPP Objective 1)
- Will increased flows to northeastern Shark River Slough yield natural distribution of waters toward the southeastern Everglades (Taylor Slough and lower C-111 basin) and northeast Florida Bay without operation of the SFWMD Canal System east of the L30, L31-N, and L31-W? (ID#61; CEPP Objective 1)
- Will CEPP improve flows to Florida Bay and the Lower Southwest coast resulting in more natural salinity patterns (magnitude, spatial distribution and timing)? Will results be consistent with the expectations from the CEPP scenario model predictions? (ID#67; CEPP Objective 2)
- Will predicted CEPP flows mitigate saltwater intrusion and associated coastal wetland vegetation, soil stability, and nutrient retention or release? (ID#64; CEPP Objective 2)
- If salinity is affected by overland flow increases through ENP to Florida Bay, how much benefit is generated for SAV, sportfish, prey, coastal wading birds, and crocodiles? Can operations be adjusted to improve estuarine performance in Florida Bay? (ID#65; CEPP Objectives 2,4,5)

Lower East Coast

- Will the constructed and operational features of CEPP maintain flood risk management (WS/FRM) level of service east of the L-30, L-31N, L-31W, and C-111 without reducing quantity or quality of groundwater in water supply wellfields compared to existing conditions? (ID#35; CEPP water supply and flood risk management constraints)
- Will the constructed and operational features of CEPP reduce surface and/or groundwater base flows and wetland/groundwater recharge to the east of the L-30 and L31-N in areas such as the Pennsuco Wetlands, south Miami-Dade wetlands, and Biscayne Bay? (ID#62; CEPP Savings Assurances constraints)

Adaptive management strategies are provided in this section to describe and address each CEPP adaptive management uncertainty and inform CEPP implementation based on the body of existing scientific knowledge in Everglades restoration. This section comprises the bulk of the CEPP adaptive management Plan and provides a 1-2 page strategy description for one or more uncertainties and summary tables of suggested management actions to improve restoration performance, as illustrated in **Table D.1.2.** First, structured 1-2 page strategy write-ups are provided for each CEPP adaptive management Uncertainty; these include information on drivers of the uncertainty, restoration targets and CEPP targets for particular attributes of the ecosystem associated with the uncertainty (such as a key species or ecological features), how these attributes will be monitored to track progress toward the targets, the timeframe in which changes in these attributes will be measurable, and identification of a trigger or threshold that would give early warning that CEPP performance is veering from restoration expectations. Note that the "timeframe in which changes will be measurable" does not imply that changes will be *complete* in that timeframe; rather, the timeframes provide an estimate of time needed to *begin* to be able to distinguish CEPP effects. For practicality, the CEPP AM Plan screening criteria included the need to have attributes measurable within the time of the AM Plan, which in some cases necessitated a 'proxy' attribute to be measured that would represent expected changes on a longer time scale. Second, following the strategies, tables of suggested management options are provided, called management option matrices (MOMs). These provide suggestions of paths forward and adjustments that can be made in order to keep CEPP progressing toward the targets based on specific decision-criteria, e.g., a trigger or threshold is crossed (reflecting unintended effects related to a constraint) or is not crossed (reflecting lack of restoration progress towards restoration goals and objectives). The purpose of the two formats is to provide A) background and detail of each strategy and B) a summary of how monitoring to reduce uncertainty is linked to specific decision-criteria and potential actions for multiple strategies in a specific area. The detailed descriptions are referred to as the "strategies" and the summary tables are referred to as "management options matrices" (MOMs) (**Table D.1.2**). The reader will notice that the amount of information provided in this section to address the uncertainties varies; this is due to some features of CEPP being new in CERP, such as the Flow Equalization Basin, while others have years of familiarity and previous knowledge, such as the salinity effects of fresh water discharges from Lake Okeechobee to the northern estuaries. The strategies and MOMs provide synopses of the best available information, which in some cases is sparse and will need to be developed further as CEPP moves toward implementation and the adaptive management plan is updated based on new information gained about the best project design and operations to achieve restoration goals.

Adaptive management activities will be implemented during the coming phases of CEPP, and the adaptive management Plan will be updated accordingly. At such time, more baseline data and lessons learned will be available from other monitoring programs and restoration projects. Given the new knowledge and answers to key questions the adaptive management options proposed in this Plan may need refinement. Therefore, items included in this plan are not guaranteed to be funded as-is, but will be considered again when CEPP is closer to being implemented and funding decisions will be made commensurate with available funding at that time.

Table D.1.2: CEPP Adaptive Management Uncertainties and Strategies Template and Definitions.
The CEPP adaptive management uncertainties and the strategies to address them are provided in the format shown here. The uncertainties and strategies are presented by region, and each region's set is followed by an 11x17 pull-out table of suggested management options that can support CEPP and potentially CERP refinement (Management Option Matrices, or MOMs). Please see further explanation in Section 1.3 above.

CEPP AM Uncertainty and ID#. *The uncertainty is a question faced during planning or implementation regarding the best restoration actions to achieve desired goals and objectives within constraints, which cannot be fully answered with available data or modeling. Uncertainties were screened and prioritized to determine which to include in the AM Plan.*

CEPP Objective or Constraint: *Uncertainties needed to related to CEPP objectives or constraints, among other criteria, to be included in the AM Plan. This rule helped to focus the scope of the AM Plan.*
Region(s). *Area of CEPP footprint to which the uncertainty and strategy pertain.*
Associated CEPP features: *Structures or measures to which the uncertainty and strategy pertain.*
Driver or uncertainty type: *Unlike most AM Plans, not all CEPP AM uncertainties and strategies are ecological. Types such as Engineering and Operations are identified.*

What is expected to be learned by addressing this uncertainty, i.e., how will CEPP benefit from addressing this uncertainty? *Why the uncertainty needs to be addressed in CEPP.*

Expectations or hypotheses to be tested to address the uncertainty, and attribute(s) that will be measured to test each. *A scientific approach begins with a well-informed, pointed, detailed statement that will be tested. For the purposes of CEPP's AM Plan the statement can be referred to as an expectation or hypothesis. Approaching uncertainties scientifically is more efficient than trial-and-error because of targeted testing; a properly identified hypothesis statement is the most important step to lead to effective, efficient methodology to address an uncertainty. It leads to proper identification of what to measure, how, how often, how to analyze, etc.*

More Information on attributes to be measured:

- **What is expected to be learned by measuring this attribute, i.e., *how will CEPP benefit from knowledge gained about this attribute?***
- **What is the time frame in which changes to this attribute are expected to be measurable?**
- **Is this attribute complimented by other monitoring programs within and/or outside of CEPP? If so, provide reference to other monitoring. Note the monitoring paid for by others in the CEPP AM budget spreadsheet.**
- **When during CEPP's life cycle should this monitoring begin and end?**

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: *More information on what to measure, how, how often, how to analyze, and when and how to report results. PLEASE NOTE: the CEPP AM Plan varies in the level of methodology detail provided; in several cases the details will be formed during CEPP's detailed design phase. In ALL cases, methodology will be reviewed, updated and adjusted if needed by agency subject experts, before initiation, to best meet the intent of the AM Plan.*

Triggers/thresholds that indicate good CEPP performance or need for adaptive management action. *Triggers or thresholds are a point, range, or limit that signifies when restoration performance is veering away from expectations and is trending toward an unintended outcome. Triggers/thresholds should be described per attribute to be monitored because each should result in an outcome that informs management decisions.*

Management options that may be chosen based on test results. *Management Options are provided in case a performance trigger or threshold is crossed, which would indicate that CEPP performance needs to be adjusted. The Management Options are suggested paths forward and adjustments that can be made to keep CEPP progressing toward objectives and within constraints. The Management Options are summarized in 11x17 pull-out tables after each region's strategies.*

1.3.1 CEPP-Wide Restoration Uncertainty and Strategy: Invasive and Nuisance Species

1.3.1.1 Invasive and Nuisance Species in the CEPP Footprint

The introduction and expansion of invasive and nuisance plant and animal species has the potential to alter the predicted CEPP restoration landscape pattern and species composition. Such species can alter plant community structure, species composition, fire frequency and intensity, habitat quality, compete with and displace native species, threaten endangered species, and alter trophic dynamics and food webs. The high profile floral and faunal invasives (e.g. *Melaleuca*, Brazilian Pepper, Burmese python) and their impacts to the landscape are well documented. However, these species are but a fraction of the invasive and nuisance species in the Everglades ecosystem. Many of the other species' life histories and responses to disturbance and treatments are insufficiently understood.

The CEPP adaptive management invasive species strategy described here focuses on consolidating species data that is existing and proposed to be collected, in order to improve CEPP's ability to target species management resources most effectively in the specific conditions that will be created by CEPP and thereby prevent invasive and nuisance species impacts on the performance of CEPP. This adaptive management strategy has been coordinated with the CEPP Invasive and Nuisance Species Management Plan (INSMP).

This topic is included in the adaptive management Plan because of its level of uncertainty and risk to CEPP outcomes, its ability to be addressed through management options, and to ensure that it remains part of CEPP discussions as lessons are learned throughout the implementation of the project.

CEPP adaptive management Uncertainty #59/66: How will CEPP influence the introduction and growth of non-native invasive and native nuisance species populations within the project area, and will the species influence the predicted landscape and performance of CEPP? (Driver or type: Ecological)

This uncertainty is related to CEPP objective of restoring a natural mosaic of wetland and upland habitat in the Everglades system, and relates to all regions and features of CEPP.

What is expected to be learned by addressing this uncertainty, i.e., how will CEPP benefit from addressing this uncertainty? It is anticipated that addressing this uncertainty will improve the understanding and ability to predict how invasive and nuisance species influence the ecosystem function and structure within the footprint of CEPP, and potentially influence the outcome of CEPP's restoration activities. Improved species profiles and prediction/risk assessment abilities can help target resources to the most effective species management activities, and can inform future design and operations of CEPP and other restoration projects to avoid expensive trial-and-error attempts to reduce the impacts of invasive and nuisance species. The proposed activities will reduce the possibility of invasive and nuisance species hindering CEPP from achieving its restoration objectives.

Expectations and hypotheses to be tested to address uncertainty, and attribute(s) that will be measured to test each. No new monitoring is proposed in this adaptive management strategy to improve predictions and risk assessment, rather, data from the CEPP INSMP and Ecological Monitoring Plan, RECOVER MAP, other CERP INSMPs and ecological monitoring plans, historic and current databases, and aerial photos may be used to develop and/or refine risk assessment tools to direct species management decisions. Before CEPP implementation this data should be consolidated in CERPZone to develop the needed species profiles and tools.

It is recommended that the causal relationship between invasive or nuisance species to restoration activities and outcomes should be investigated as the data is consolidated. For example, the following CEPP-specific questions may be pursued: Does backfilling of canals increase or reduce abundance of invasive fish? Does removal of levees reduce spread of terrestrial invasive species that use levees as primary corridors? Do spoil mounds provide stepping stones for invasive and nuisance species that can travel through the marsh? As CEPP adaptive management Plan implementation approaches, the invasive and nuisance species experts among the agencies and interested stakeholders should be consulted to identify the most relevant species and questions to investigate and methods to follow. Species should be chosen based in part on their ability to represent a broader group of species in order to maximize the knowledge gained from monitoring their responses.

Methodology for testing each expectation or hypothesis. No new monitoring is proposed as part of the CEPP Adaptive Management Plan to address this uncertainty; please see the CEPP INSMP for details about species and surveillance methodology. In addition, the CEPP Ecological Monitoring Plan to monitor project success includes vegetation change monitoring. During this monitoring plant species will be documented in locations that will be deemed sentinel sites by invasive and nuisance species agency experts for measuring CEPP's restoration success. If invasive or nuisance plant species are found at these sites the CEPP vegetation management teams at the implementing agencies will be notified and will address the presence of the species as specified in the INSMP. Regarding fauna, USACE contracts include a requirement to report invasive or nuisance animal species to the project's environmental lead and the Invasive Species Management Branch. A similar requirement will be pursued for CERP project and program level monitoring.

Consolidation of existing information and refinement or development of Invasive Risk Assessment Tools are suggested prior to CEPP implementation to better define triggers for when management actions should be taken and avoid expensive negative impacts through a reactive management approach.

How results will be reported, and the triggers/thresholds that indicate good CEPP performance or need for adaptive management action: Lessons learned will be provided as feedback to the next stages of CEPP design, construction, and implementation by the invasive and nuisance species agency experts during interactions with CEPP Design Team, Operations, and others as appropriate. There are currently several forums for sharing this information and we anticipate similar forums in the future. The INSMP is a living document that will also be updated with lessons learned.

Management options that may be chosen to reduce the impacts of invasive species. Feedback to CEPP management could include informing project decisions such as timing of delivering water, or routing water through an area slightly differently than originally specified, in addition to informing the invasive and nuisance species management team actions. Suggested adaptive management options listed below are not in any particular order and can be implemented simultaneously, as appropriate.

- Refinement or development of Invasive Risk Assessment Tools.
- Implementation of Invasive and Nuisance Species Management Plan to immediately identify and eradicate new opportunistic/highly mobile invasive exotic species in areas of concern (e.g. active construction sites).
- Implementation of Invasive and Nuisance Species Management Plan for a regional approach to suppress, control, and/or eradicate slow-growing/less mobile species.
- Suppression of established invasive species to the lowest feasible level such that ecosystem impacts are minimized.

- Redesign of existing or planned features, as appropriate and based on lessons learned, to make them less supportive of invasive exotic species proliferation/movement.

1.4 CEPP's Flow Equalization basin, Lake Okeechobee, and the Northern Estuaries

A clear relationship between the health of the northern estuaries habitats and the volume and timing of fresh water discharges from Lake Okeechobee and the estuarine watersheds has been established (Doering and Chamberlain, 1999; Barnes, 2005; Sime, 2005). Discharges change salinity in the estuaries, which affects the health, reproduction, and survival of key species. These species have an ideal range of salinity, and can tolerate some variations; their range of salinity is referred to as the "salinity envelop". Likewise, key species in the Lake represent the Lake's ecological health (Havens and Gawlik, 2005). These species have an ideal range of water depth in the Lake and can also tolerate some variations; their ideal water depth range can be referred to as a "stage envelop". In CEPP's planning, great care was taken to determine operations that balance the stage needs of the Lake and the salinity needs of the northern estuaries while routing as much water as possible south, through the FEB and stormwater treatment area (STA) and beyond to the Everglades. The adaptive management questions in this northern region of CEPP focus on achieving the balance among these closely related systems using the deep level of knowledge about the needs of the estuarine and lake habitats, as well as water quantity and quality needs of the Greater Everglades.

1.4.1.1 CEPP Flow Equalization Basin (A-2 FEB)

The CEPP Flow Equalization Basin (called the A-2 FEB) will be integrated with the State's FEB-1 and operations will be optimized to maximize the water quantity and quality performance based on information gained from implementing the State's Restoration Strategies and learning from the State's Science Plan. Flow Equalization Basins are used to attenuate high flows from upstream of STAs and then to regulate flows of water to be treated by the STA to improve their overall performance. The A-2 FEB is the CEPP project component that will be operationally integrated with the State's water quality treatment features (FEB-1, STA2 and STA 3/4) to meet the water quality-based effluent limit (WQBEL) requirements for delivering the CEPP water to WCA3A. Together, the integrated FEB-1 and the A-2 FEB unit will store and then manage the delivery of water to STA2 and STA 3/4 for treatment prior to making deliveries to WCA3A as part of CEPP plan. The majority of the new CEPP flows to the central Everglades system will be made primarily during the dry season when the natural system needs it the most. However, there are potential water quality compliance risks associated with treatment of CEPP flows using the existing conveyance features and FEB-1, STA 2 and STA 3/4 capacity.

Storage and deliveries from the integrated FEB-1 and A-2 FEB unit to the STA 2 and STA 3/4 will be different than the FEB-1 project alone. It is anticipated that once the A-2 FEB comes online the Restoration Strategies Plan will have been operated, monitored and optimized for several years. As such, there should be sufficient time and information to evaluate system performance and initiate structural and/or operational modifications to the CEPP plan if needed prior to finalizing the design of the A-2 FEB features. In addition, the State's Science Plan will have been refined over time and updated with information that can be used to refine the CEPP Adaptive Management Plan with more detail on methods, measures, targets, management options, and logistics and to include integration of the A-2 FEB.

CEPP Adaptive Management Uncertainty #4: How can we most effectively learn from the FEB-1 to integrate FEB-1 and the A-2 FEB, to optimize their operations to maximize flows to the Everglades via

the FEBs while balancing the related needs of Lake Okeechobee and the northern Everglades? (Driver or uncertainty type: Structural operations)

This uncertainty is related to CEPP objectives for delivering treated water to restore natural hydroperiods and freshwater distribution, improving surface water depths and durations, and reducing high volume discharges from Lake O to the northern estuaries. It relates to the CEPP area that is north of WCA 3A (north of the “redline”). The associated CEPP and non-CEPP features are Lake Okeechobee operations, existing conveyance features, FEB-1, the A-2 FEB, STA2 and STA3/4.

What is expected to be learned by addressing this uncertainty, i.e., how will CEPP benefit from addressing this uncertainty? A significant portion of the restoration anticipated from CEPP relies on the integrated performance of FEB-1, the A-2 FEB, and STA 2 and STA 3/4. Addressing uncertainty #4 will inform efforts to optimize performance to meet the necessary water quality compliance requirements, while delivering water into WCA 3A mostly during the dry season.

Expectations and hypotheses to be tested to address uncertainty #4, and attributes that will be measured to test each: Based on modeling conducted during CEPP planning, it is anticipated that integrated A-2 FEB and FEB-1 operations working together with STA2 and STA 3/4 will meet water quality requirements and deliver an estimated additional flow of ~210,000 acre-feet per year (long-term annual average) to WCA 3A to improve Everglades hydroperiods, freshwater distribution, surface water depths and durations, and to reduce the number of high volume discharges from Lake O to the northern estuaries. It is also expected that integrated the A-2 FEB and FEB-1 in-flow, out-flow, and operations will be controlled by several factors: 1) volume of water and nutrient load coming into and out of the integrated FEB-1 and the A-2 FEB unit; 2) STA 2 and STA 3/4 capacity to accept additional quantities of water; and 3) ability to meet the WQBEL and 4) down-stream (WCA 3A) recession rate constraints. *The specific tests that may be needed for CEPP’s adaptive management to address uncertainty #4 are TBD after implementation and observations of the State’s Restoration Strategies performance.*

Attributes to be measured: Together, the integrated FEB-1 and the A-2 FEB units will store and then manage the delivery of water to STA2 and STA 3/4 for treatment prior to making water deliveries to WCA3A as part of CEPP plan. The CEPP adaptive management strategy for the A-2 FEB uncertainties are to learn from design, construction, operations of state of Florida’s FEB-1 project that is part of the state water quality strategies. FEB-1 uncertainties will be addressed as part of the State Water Quality Science Plan. Additional information will likely be needed when the A-2 FEB is constructed and integrated with FEB-1 by CEPP; this monitoring should build upon and be complimentary to that of the Restoration Strategies project. The attributes to be measured are to be determined, but are likely to include the quality and quantity of fresh water delivered into and out of the integrated FEB-1 and the A-2 FEB units, STA 2 and STA 3/4, water into WCA 3A. This information will most likely be needed for defining operating protocols and ensuring water quality compliance is met. Time frame in which changes are expected to be measurable: Beginning during the first dry season after the A-2 FEB and FEB-1, and monitoring may continue for up to 10 years after initiating integrated operations.

Time frame in which changes are expected to be measurable: Beginning during the first dry season after the A-2 FEB implementation; throughout the life of CEPP.

Methodology for testing each expectation or hypothesis. Locations, frequency, and detailed methodology for monitoring should be developed during the design of the A-2 FEB when more information is available from implementation and operations of Restoration Strategies. Thresholds and criteria to optimize operations will be developed during design based on information from State Water Quality Science Plan results. When the FEB-1 monitoring program is in place and the operational testing period begins, the CEPP adaptive management plan can be updated to include what might be necessary for the A-2 FEB. Specific monitoring requirements associated with those thresholds are unknown at this point but will be estimated based on the FEB-1 monitoring costs. Once details are developed, monitoring and reporting should be coordinated and combined as much as possible with the CEPP Water Quality and Hydrometeorological Monitoring Plans (this Annex).

A. During detailed design of the A-2 FEB, inflow and outflow estimates will need to be developed for the FEB-1 and A-2 FEB unit, STA2 and STA3/4. Once constructed and operational, the CEPP project components can then be monitored during commissioning and long term operations in real time to check, optimize and validate performance.

How results will be reported and the triggers/thresholds that indicate good CEPP performance or need for adaptive management action. Thresholds and criteria to optimize operations will be developed during design based on information gained from implementation and operation of the State's Restoration Strategies and results of the State's Science Plan. Once the Restoration Strategies monitoring program is in place and the operational testing period is completed, the CEPP adaptive management plan can be updated to include information gained and what might be necessary for integration of the FEB-1 and A-2 FEB unit. Specific monitoring requirements associated with those thresholds are unknown at this time but will be derived based on the Restoration Strategies implementation, operations and monitoring.

Management options that may be chosen based on test results. Management options will be informed by the results from Restoration Strategies implementation and the associated State Water Quality Science Plan findings and may include structural and operational modifications and/or physical adjustments.

CEPP adaptive management Uncertainty #4: How can we most effectively learn from the FEB-1 to integrate FEB-1 and the A-2 FEB, to optimize their operations to maximize flows to the Everglades via the FEBs while balancing the related needs of Lake Okeechobee and the northern Everglades? (Driver or uncertainty type: Structural operations)

This uncertainty is related to CEPP objectives for water quality, restoring natural hydroperiods and freshwater distribution, improving surface water depths and durations, and reducing high volume discharges from Lake O to the northern estuaries. It relates to the CEPP area that is north of WCA 3A (north of the "redline"). The associated CEPP and non-CEPP features are Lake Okeechobee operations, existing conveyance features, FEB-1, A-2 FEB, STA2 and STA3/4.

What is expected to be learned by addressing this uncertainty, i.e., how will CEPP benefit from addressing this uncertainty? A significant portion of the restoration anticipated from CEPP relies on the integrated performance of FEB-1, A-2 FEB, and STA 2 and STA3/4. Addressing uncertainty #4 will inform efforts to optimize performance to meet the necessary water quality compliance requirements, while delivering water into WCA 3A mostly during the dry season.

Expectations and hypotheses to be tested to address uncertainty #4, and attributes that will be measured to test each: Based on modeling conducted during CEPP planning, it is anticipated that integrated A-2 FEB and FEB-1 operations working together with STA2 and STA3/4 will meet water quality requirements and deliver an estimated additional flow of ~210,000 acre-feet per year (long-term annual average) to WCA 3A to improve Everglades hydroperiods, freshwater distribution, surface water depths and durations, and to reduce the number of high volume discharges from Lake O to the northern estuaries. It is also expected that integrated A-2 FEB and FEB-1 in-flow, out-flow, and operations will be controlled by several factors: 1) volume of water and nutrient load coming into and out of the integrated FEB-1 and A-2 FEB unit; 2) STA 2 and STA 3/4 capacity to accept additional quantities of water; and 3) ability to meet the WQBEL and 4) down-stream (WCA 3A) recession rate constraints. *The specific tests that may be needed for CEPP's adaptive management to address uncertainty #4 are TBD after implementation and observations of the State's Restoration Strategies performance.*

Attributes to be measured: Together, the integrated FEB-1 and A-2 FEB units will store and then manage the delivery of water to STA2 and STA 3/4 for treatment prior to making water deliveries to WCA3A as part of CEPP plan. The CEPP adaptive management strategy for the A-2 FEB uncertainties are to learn from design, construction, operations of state of Florida's FEB-1 project that is part of the state water quality strategies. FEB-1 uncertainties will be addressed as part of the State Water Quality Science Plan. Additional information will likely be needed when the A-2 FEB is constructed and integrated with FEB-1 by CEPP; this monitoring should build upon and be complimentary to that of the Restoration Strategies project. The attributes to be measured are TBD, but are likely to include the quality and quantity of fresh water delivered into and out of the integrated FEB-1 and A-2 FEB units, STA 2 and STA 3/4, water into WCA 3A and at WQBEL monitoring compliance locations. This information will most likely be needed for defining operating protocols and ensuring water quality compliance is met. Time frame in which changes are expected to be measurable: Beginning during the first dry season after A-2 FEB and FEB-1 integration and CEPP operation; throughout the life of CEPP.

Time frame in which changes are expected to be measurable: Beginning during the first dry season after A-2 FEB implementation; throughout the life of CEPP.

Methodology for testing each expectation or hypothesis. Locations, frequency, and detailed methodology for monitoring should be developed during the design of the A-2 FEB when more information is available from implementation and operations of Restoration Strategies. Thresholds and criteria to optimize operations will be developed during design based on information from State Water Quality Science Plan results. When the FEB-1 monitoring program is in place and the operational testing period begins, the CEPP adaptive management plan can be updated to include what might be necessary for the A-2 FEB. Specific monitoring requirements associated with those thresholds are unknown at this point but will be estimated based on the FEB-1 monitoring costs. Once details are developed, monitoring and reporting should be coordinated and combined as much as possible with the CEPP Water Quality and Hydrometeorological Monitoring Plans (this Annex).

A. During detailed design of the A-2 FEB, inflow and outflow estimates will need to be developed for the FEB-1 and A-2 FEB unit, STA2 and STA3/4. Once constructed and operational, the CEPP project components can then be monitored during commissioning and long term operations in real time to check, optimize and validate performance. Ultimately, meeting the necessary water quality compliance standards will be the major contributing factor in the ability to deliver approximately 210,000 acre-feet of restorative flows per year on a long-term annual average to WCA 3A.

How results will be reported and the triggers/thresholds that indicate good CEPP performance or need for adaptive management action. Thresholds and criteria to optimize operations will be developed during design based on information gained from implementation and operation of the State's

Restoration Strategies and results of the State's Science Plan. Once the Restoration Strategies monitoring program is in place and the operational testing period is completed, the CEPP adaptive management plan can be updated to include information gained and what might be necessary for integration of the FEB-1 and A-2 FEB unit. Specific monitoring requirements associated with those thresholds are unknown at this time but will be derived based on the Restoration Strategies implementation, operations and monitoring.

Management options that may be chosen based on test results. Management options will be informed by the results from the State's Restoration Strategies implementation and the associated Science Plan findings and may include structural and operational modifications and/or physical adjustments.

1.4.1.2 Lake Okeechobee's Balance with Northern Estuaries and the CEPP FEB

This CEPP adaptive management uncertainty highlights the balance needed between maintaining Lake Okeechobee (Lake) at ecologically beneficial, water supply and flood risk management appropriate lake stages, the ecological performance in the northern estuaries, and the need to send water from the Lake to the FEB. The strategy proposes analysis of data, from existing monitoring programs that would be continued during CEPP's implementation, to determine if CEPP's operations affect the Lake's littoral and nearshore vegetation while CEPP also attempts to improve conditions in the estuaries and deliver water south to the Everglades during the dry season. The hypothesis, monitoring, and data analysis in this strategy focus on the Lake. FEB and estuarine monitoring are described separately.

Modeling of the hydrology of the Lake-estuaries-FEB shows that the estuaries will receive fewer high-flow events that violate the salinity envelopes of the northern estuaries, and the Lake will at times have higher stages (while remaining within the current operation schedule), which has the potential to affect the Lake's vegetation. The critical issue will be what time of year and for what duration Lake stages are higher. High lake stage allows wind-driven waves to uproot emergent and submergent plants in the nearshore region. It may also result in re-suspension or transport of suspended solids in or to the nearshore and littoral regions, reducing water clarity and light penetration, resulting in less submerged aquatic vegetation growth. Another issue is if stage reversals occur during the spring recession, bird species such as snail kites or ground nesters could be adversely affected by flooding of nests. Small stage reversals (*e.g.*, < 6") may also flood apple snail egg masses, even though it may take larger stage reversals to cause detectable changes to vegetation in the lake. Vegetation impacts would also probably not be detectable if a stage increase is of short duration; *i.e.*, 1-3 months. In conclusion, we expect that higher water levels resulting from CEPP should be infrequent and of short enough duration to prevent significant reductions in the littoral and near shore vegetation under higher lake stages (*e.g.*, >15 ft NGVD)(for more detail see the interagency scientists' review of CEPP, Annex E). This adaptive management plan was designed to verify that expectation and to inform potential future decisions if Lake Managers need to address unintended CEPP influences on the Lake.

CEPP adaptive management Uncertainty #3: Do CEPP's operational refinements for Lake Okeechobee, which are projected to keep lake stage within LORS 2008 regulation schedule and which reduce the duration and number of high volume fresh water discharge events for the northern estuaries, affect the Lake Okeechobee littoral and nearshore vegetation coverage? Driver or uncertainty type: Ecological and operational; balancing multiple objectives (water supply, flood control, and ecological health of the lake and estuaries).

This uncertainty is related to the CEPP constraint of remaining within the approved operating schedule of Lake Okeechobee and doing no ecological harm to the Lake. It focuses on the ecological effects in Lake Okeechobee of operations in the region that will balance the needs of the Lake, the northern estuaries, and will optimize the volume and timing of water to send south to the Everglades. The associated CEPP and non-CEPP features are Lake Okeechobee operations, FEB-1, A-2 FEB, STAs 3/4, C-44 Reservoir, C-43 Reservoir, storage of additional water north of the Lake, and Indian River Lagoon-South Project.

What is expected to be learned by addressing this uncertainty, i.e., how will CEPP benefit from addressing this uncertainty? CEPP was designed to not negatively impact the Lake ecosystem, which is represented here by the relationship between vegetation and lake stage. The purpose of this adaptive management item is to detect unintended negative effects early and provide reliable data analysis for subsequent discussions of Lake regulation schedule modifications that could be needed.

Expectations and hypotheses to be tested to address uncertainty #3, and attribute(s) that will be measured to test each. During CEPP planning, the conclusion of model evaluation of Alts 1-4 indicated that CEPP had a low potential to impact vegetation (CEPP PIR, **Annex E** - RECOVER System-wide Evaluation of CEPP) because stage differentials between the TSP and the FWO were typically small, intermittent and had sufficient recovery time between them. Therefore, the expectations to be checked are that there usually will be no discernible negative littoral or near shore vegetation impacts in the Lake resulting from CEPP's operational changes, which will hold additional water in the lake compared to current operations. (Note: the additional water held in the Lake remains within the current LORS 2008 requirements.) The modeling runs evaluated by RECOVER suggest that the timing, duration, and return frequency of events evaluated with Lake performance measures will usually not decrease the Lake's vegetation.

Attributes to be measured to examine the potential impacts of additional lake stages resulting from CEPP include quantifying the additional water held in the Lake and associated change in lake stages, and associated changes in littoral and nearshore vegetation areal coverage. Lake stages and vegetation coverage are currently monitored by the SFWMD. SFWMD tracks Lake stages and provides weekly updates and a weekly stage hydrograph. If this tracking continues then pre-CEPP and post-CEPP Lake stage data would be available. These data would show if the CEPP is holding the Lake >6 inches above the ecological performance measure stage envelope, for durations greater than 1 month. If such incidents occur, they will be tracked and compared with the vegetation data (described next). Existing meteorological data in conjunction with water control structure data will be analyzed to determine whether changes are due to CEPP or due to Climatic Changes (e.g., period of increased rainfall), as Lake Okeechobee monthly stages are significantly correlated to prior two years watershed rainfall (RECOVER, 2009).

Currently the SFWMD Lake and River Ecosystem Section conducts monitoring of the Lake's nearshore submerged aquatic vegetation (SAV) and littoral emergent vegetation via aerial photography and ground-truthing, to estimate vegetation coverage. The EAV and SAV monitoring is anticipated to continue so that changes in vegetation coverage over time can be detected. If Lake stages are held significantly higher with CEPP, then the vegetation data can be analyzed for changes associated with the additional lake stages. No additional monitoring is currently suggested for this uncertainty. Instead, CEPP-specific data analysis and reporting is proposed to address: if and when the Lake stages are held slightly higher, due to CEPP, are the higher stages affecting the littoral and near shore vegetation?

More Information on Attributes to be measured:
For each attribute, specify the following.

- **What is expected to be learned by measuring this attribute, i.e., how will CEPP benefit from knowledge gained about this attribute?** Data on the Lake's stages and the vegetation coverage are needed to test whether CEPP affects the Lake vegetation.
- **What is the time frame in which changes to this attribute are expected to be measurable?** Within 1 year of operating CEPP, when additional water is stored in the lake, resulting from CEPP operations.
- **When during CEPP's life cycle should this monitoring begin?** Since monitoring programs currently exist, they will not need to be initiated but should instead be continued in order to collect legitimate pre- and post-CEPP data. Conversely, if the current level of monitoring is decreased, then baseline monitoring will need to begin 3 to 5 years prior to the CEPP A-2 FEB becoming operational.

Methodology for testing each expectation or hypothesis (include frequency of monitoring). No new monitoring is proposed to address this uncertainty; instead existing monitoring programs should be maintained to gather the needed data. CEPP-specific analysis would be needed to determine if CEPP operations affect vegetation coverage. A total of four weeks per year of additional data analysis and reporting has been proposed in the CEPP adaptive management budget for addressing this uncertainty, when significant increases in lake stage occur due to additional water storage resulting from CEPP.

How results will be reported, and the triggers/thresholds that indicate good CEPP performance or need for adaptive management action. There are several forums in which potential effects of CEPP on the Lake can be reported, ranging from weekly Operations and Periodic Scientist calls, the annual SFER and multiple-year System Status Reports. The trigger or threshold that signifies action needed: Significant decrease in littoral or near shore vegetation coverage, *i.e.*, a reduction in vegetation coverage of >10% which persists for one growing season (Spring to Fall) that is causally linked to instances of withholding more water in the Lake resulting from CEPP. A more refined threshold that identifies optimal species distribution and composition may be developed, and could be informed by the following existing sources of information:

- Spatial extents in acres of marginal and optimal habitat are provided in the 2008 LORS Biological Opinion. However, the distribution of habitat types has significantly changed with dry years since 2008; updated information should be used to make accurate assessments of CEPP's effects.
- Lake Okeechobee Regulation Schedule thresholds for littoral vegetation from Endangered Species Act (ESA) consultation (Snail Kite critical habitat).
- There is no completed RECOVER performance measure for Lake Okeechobee littoral zone emergent vegetation, but the 2012 System Status Report update contains information on when the draft PM guidelines have been met or not met (SSR 2012).
- Current data indicates that some plant species respond to changes in hydroperiod in the course of less than a year, which helps to inform the hypothesis provided below.
- An SAV model for the lake has recently been developed by K.R. Jin at the SFWMD. If approved by the USACE, it could be used to refine our expectations of Lake stage effects on vegetation.
- Additional modeling efforts may be able to further quantify lake stage – vegetation relationships and the potential ecological benefits of building additional water storage in the watershed.
- The Florida Fish and Wildlife Commission also conducts Lake monitoring, focused on fish species. It is to be determined if or how the fish monitoring could contribute to addressing the

adaptive management Uncertainty described here about the ecological effect of refinements to Lake O operations.

- The USACE is funding apple snail and snail kite monitoring on the Lake as required by the BO for the 2008 LORS. It is to be determined if or how this monitoring could contribute to addressing this CEPP uncertainty.
- Other as yet untested methods that may be developed in the intervening 15+ years until A2 FEB comes on-line
- A revision of the nearshore SAV PM, from the amount of total areal coverage, to the amount of potentially colonizable habitat that contains SAV, may be used to determine nearshore SAV health.

Management options that may be chosen based on test results are included in the Management Options Matrices (MOM) for Lake Okeechobee, the CEPP FEB, and the northern estuaries, which are all linked to each other.

Table D.1.3: Lake Okeechobee (LO) balance with Northern Estuaries Management Options Matrix.

The Management Option Matrix (MOM) shown here, and those throughout the adaptive management Plan, help link monitoring identified in specific adaptive management strategies, to decision criteria and suggested management options to consider for adjusting CEPP if monitoring reveals performance issues related to CEPP operations on Lake Okeechobee's ecology. For the CEPP adaptive management Plan, nearshore and littoral zone vegetation represents the Lake's ecology. Currently no alternate explanations for changes in vegetation are included, such as increased fish populations. After authorization of CEPP and before implementation of the CEPP adaptive management Plan it is recommended that such possibilities be considered and accounted for in this and other CEPP adaptive management strategies to the extent possible.

Uncertainty tracking ID#	**Timeframe to detect change of attributes**	**Attribute or indicator**	**Specific Property to be Measured and Frequency**	**Decision Criteria: Trigger(s) for Management Action**	**Management Action Options Suggestions**
#3	<1 year	Native vegetation in LO littoral and nearshore zones	Acres of native vegetation Vegetation species composition	Significant decrease(>10%) in littoral or near shore vegetation coverage, which persists for one growing season (Spring to Fall) and causally linked to instances of withholding more water in the Lake resulting from CEPP	• Adjust operations to hold more water in Lake at times when less likely to impact vegetation (within the LORS schedule), • Adjust operations to send more base-flow water to the estuaries, if flow won't impact salinity envelopes, • Adjust operations to move more water to the FEB during periods of ecologically harmful high lake stages to prevent additional ecological damage in the Lake and estuaries. • Adjust operations to share the balance of extra water between the Lake and the estuaries until increased capacity and storage are available, i.e., this could include alternating between sending water to the estuaries or keeping it in the Lake during times of excess water. (This information will better inform the weekly operations call discussions and increase the options that are discussed) **Potential considerations for future CERP and non-CERP restoration projects:** More storage reservoirs, particularly north of the Lake; Increased canal capacity between the Lake and the FEBs to improve ability to move water quickly to the FEBs when needed to avoid discharging it to the estuaries or holding Lake levels high; Refer to the SFWMD Restoration Strategies for lessons learned on measures that could relieve burden on the STAs, which are the bottleneck that control the movement of water from the Lake to the Everglades; If a discussion ensues about the Lake schedule it is suggested that streamlined modeling can show effects of Lake changes on Lake vegetation.

1.4.1.3 St. Lucie Estuary

The CEPP FEB and Lake Okeechobee (LO) operational adjustments combined with Indian River Lagoon South operations are intended to help reduce high flows from the LO and basin runoff to the northern estuaries. Uncertainty exists in whether the FEB will improve LO high flow releases during the wet season to the degree necessary to reduce low salinity events in the south fork portion of the St. Lucie that stress both benthic, SAV and oysters. In addition, uncertainty exists regarding the recovery of SAV in the estuary if additional measures are not taken to improve water clarity and sediment problems, such as removal of mucky sediments and further Best Management Practices (BMPs) in the watershed that will be needed to improve water quality.

CEPP Adaptive Management Uncertainties: There is a group of closely-related ecological uncertainties in the St. Lucie Estuary.

- Do reductions of high volume fresh water discharges (high flows) result in measurable increases in submerged aquatic vegetation (SAV) coverage in St. Lucie Estuary (SLE)? (ID#1)
- To what extent will the reduction in the frequency and magnitude of high flows to the SLE help reestablish historic oyster beds on the South Fork SLE? (ID#45)
- To what extent will the reduction in the frequency and magnitude of high flows to the SLE stabilize conditions enough to improve benthic habitat in the SLE in the south fork? (ID#46)

This group of uncertainties is related to the CEPP objective of reducing high volume discharges from Lake Okeechobee to the northern estuaries. The region is Lake O – northern estuaries. The associated CEPP and non-CEPP features are Lake O operations, the FEBs, the Indian River Lagoon-South project and C-44 reservoir, and S-80.

What is expected to be learned by addressing this uncertainty, i.e., how will CEPP benefit from addressing this uncertainty? CEPP benefits to the St. Lucie estuary can be optimized if sufficient information about the on-the-ground effects of CEPP on the estuaries is gathered and reported.

Expectations and hypotheses to be tested to address the St. Lucie Estuary uncertainties, and attributes that will be measured to test each. The following hypotheses and performance expectations are supported by the modeling results reported in the RECOVER System-wide Evaluation of CEPP Report (**Annex E**). The proposed monitoring may be complimented by RECOVER northern estuaries monitoring programs and by project-level monitoring. The locations of CEPP-specific monitoring proposed here will be conducted in the specific locations where CEPP planning modeling showed effects from CEPP.

A. High Flow Salinity (pertains to uncertainties #1, 45, 46)

- CEPP will result in a greater percentage of time that the preferred salinity range of 12-20 psu is met (32.4% to 43%), based on planning modeling results.
- CEPP will result in fewer high flows to SLE, based on planning model results that showed reduction from 30% to 17% in the number of high flow discharge violations (151 to 86 high flow >2000cfs at St. Lucie Structures over 41-year period of record).

B. Benthic habitat (pertains to uncertainty #46)

- CEPP will result in an improvement in benthic habitat that will result in Marine Biotic Index (MAMBI) score improvement in the south fork and potentially the middle estuary due to improve salinities. Expected improvement by one benthic MAMBI score in the south fork

monitoring sites M4 and M5; expected to move from Moderate (orange) to Good (green) at site M4 and Good (green) to High (blue) at site M5.
- Alternatively, CEPP may not result in an increase in benthic habitat due to poor sediment and water quality in the SLE.

C. Submerged Aquatic Vegetation (SAV) (pertains to uncertainty #1)
- CEPP will increase SAV bed density (# shoots/acre) of manatee grass by 20%, measured at Boy Scout Island. This is based on planning modeling that showed a decrease in die-off events and increase in *Halodule* acreage, shoot density, and blade length in the area directly outside of the mouth of the SLE at Boy Scout Island from 1,873,297 shoots per acre to 2,249,388 shoots per acre.
- CEPP will improve seagrass shoot density in other areas where seagrass already exists, where salinity range is met.

D. Oysters (pertains to uncertainty #45).
- CEPP will increase the density of oysters (# oysters/acre) by 9% in existing beds measured at Roosevelt Bridge to 594,737 to 650,890. This is based on planning modeling that showed a 10.9% increase in oyster density at the oyster beds located in the middle St. Lucie Estuary.
- CEPP will increase density of oysters at historical beds, where salinity range is met.
- CEPP may impact oyster mortality due to increased predation and/or disease due to low flow violations.

More Information on Attributes to be measured:
- **What is expected to be learned by measuring this attribute, i.e., how will CEPP benefit from knowledge gained about this attribute?** The attributes have been identified as indicators of ecological health in the St. Lucie estuary and indicators of restoration performance. They are the minimal efficient attributes to monitor CEPP performance in the St. Lucie.
- **What is the time frame in which changes to this attribute are expected to be measurable?** See triggers and thresholds below.
- **Is this attribute complimented by other monitoring programs (within and/or outside of CEPP)?** The monitoring is complimented by RECOVER MAP and restoration project monitoring. The locations for CEPP monitoring are focused in areas where CEPP modeling showed the most likelihood to achieve restoration benefits in the St. Lucie estuary.
- **When during CEPP's life cycle should this monitoring begin?** If pre-CEPP estuarine monitoring can be used for baseline comparison, this monitoring should begin when CEPP changes flows to the estuaries by routing water to the FEB complex and Everglades rather than discharging it to the estuaries.

Methodology for testing each expectation or hypothesis (include frequency of monitoring). The above hypotheses will be tested by monitoring restoration performance related to improved salinities in the St. Lucie Estuary due to reduction of high flows at S-80, after implementing the A-2 FEB. Three primary indicators (benthic invertebrate community health, SAV, oysters) will be used as multiple lines of evidence to verify ecological restoration response to improve salinities. Information will feedback into improved operations of the A-2 FEB in coordination with Lake Okeechobee and IRL-S, as well as future CERP increments related to storage to further reduce high flow discharges to the estuaries. In addition, the monitoring will confirm whether water quality (nutrients) and/or sedimentation (total suspended solids) may be affecting restoration performance, which would need to be addressed by IRL-S implementation and/or future CERP increments and State water quality best management practices.

IRL-S is an important CERP project that works synergistically with CEPP to improve high freshwater flows from the basin and also addresses associated sediment and nutrient inputs from the basin, thus reducing stress on the both benthic invertebrates, SAV, and oysters. If that project is not implemented, the benefits to SAV (acreage and shoot density), benthic invertebrates (improved community health index scores), and oysters (increased density per acre) associated with CEPP may not be realized. If the IRL-S C-44 reservoir is operational before the A-2 FEB, then CEPP baseline monitoring in the northern estuaries will document the changes due to that project to differentiate from changes resulting from CEPP.

How results will be reported, and the triggers/thresholds that indicate good CEPP performance or need for adaptive management action. The associated thresholds identified in the statement of hypotheses on page D.1-21 combined with the following monitoring parameters and timing are identified to help determine in the future whether adjustments to CEPP operations are needed, and they may additionally inform future restoration projects by providing lessons learned.

- *Flows and Salinity*: High flows and low flows are compared to rainfall, and expected to show changes compare to baseline in a minimum of 2 years, as well as comparable water years in the modeling period of record. If no changes are observed, then operational adjustments would be the next action. Rainfall will be measured from National Weather Service data in the basin. Existing monitoring of flow and salinity will be used with the exception of adding a salinity recorder at the Palm City Bridge. Flows are measured by continuous recorders at the salinity control structures in the SLE (S-80, S-49, S-48, and Gordy Road). Salinity can be measured at Roosevelt (US1) Bridge (existing monitoring by SFWMD) and Palm City Bridge (needs to be added).
- *Water Quality*: Existing water quality monitoring at 10 stations in the St. Lucie Estuary will be used to detect water quality conditions to determine if they have changed from the baseline. Nutrients may be a confounding factor to investigate if salinity goals are met, but ecological indicators did not respond.
- *Benthic*: A minimum of 2 years is needed to detect progress in the MAMBI benthic community index score, after achieving the right flows and salinity. The RECOVER monitoring should be used to inform CEPP restoration progress. Particularly in the South Fork estuary, sites M4 and M5 can be compared to the middle estuary and IRL-S sites to determine if the change is due to improvements in reducing high flows from the S-80.
- *SAV*: A minimum of a 4 year period to compare to baseline and look for incremental progress towards CEPP performance expectation for both indicators. RECOVER monitoring and sampling protocol will be used. Additional resolution is needed in South Fork, North Fork, and 2-3 years in the middle to outer estuary. RECOVER does not monitor St. Lucie only IRL and outer point at St. Lucie (Willoughby Cove). In addition, mapping of SAV in St. Lucie every 2-3 years is needed to detect additional areas that may have improved seagrass coverage (*Halophila* and *Halodule* seagrass species). The quadzilla mapping technique or cheaper option should be used to quantify change in SAV acreage in areas where salinity is expected to have improved resulting in increased chance of SAV expansion.
- *Oysters*: A minimum 4 year period to compare to baseline and look for incremental progress towards CEPP performance expectation for oyster density and oyster health. RECOVER monitoring can be used to monitoring oysters in the north and south forks of the St Lucie Estuary and in 2 areas in the middle estuary. Current RECOVER sampling protocol samples live-dead counts two times a year. It is recommended to increase live-dead counts to four times a year (April, June, October, January) to be able to analyze potential increase in oyster density related to CEPP by teasing out inter-annual variation due to climatic changes. In addition, high flow or low flow event driven monitoring should be conducted. RECOVER monitoring that measures recruitment, growth,

predation, disease in existing locations can be used to understand how flow performance measure violations may be impacting salinity issues that affect these oyster parameters.

Management options that may be chosen based on monitoring results. One key assumption to be considered before determining whether management options should be implemented for St. Lucie Estuary is whether the A-2 FEB is meeting its expected 210,000 average acre-ft per year delivery of water south to the Greater Everglades, which means it is accepting water from Lake Okeechobee. As described in the strategy above to address the A-2 FEB uncertainties, the methods of measuring the FEB performance and output are TBD until more is learned from the State's Science Plan is implemented and lessons are learned from FEB-1. If the FEB is unable to accept much Lake water and the Lake stages are not held slightly higher within the LO regulation schedule as planned in CEPP, then we would not expect many CEPP benefits in the St. Lucie Estuary. Operations of the Lake and FEB will be optimized to meet the average volume delivery goal and where possible to get additional reduction of high-flow discharge events beyond what was estimated in the modeling, as well as minimize low flow exceedence events. The following options are consistent with CERP SAV, benthic invertebrates, and oyster indicators:

- **If there is an issue with flows:** Optimize flows between IRL-South, Lake Okeechobee, and CEPP; consider increasing water storage capabilities in the next increment of CERP (see CEPP PIR section, "Future Opportunities").
- **If there is an issue with sediment**: Evaluate benthic monitoring results as first indicator of issues with sediment. If results suggest that despite salinity improvements the ecological restoration is hindered by undesired sediment (potentially high organic, anoxic, high sulfide muck) then muck removal may be needed. Muck removal is not part of the CEPP TSP nor has it been evaluated during CEPP planning; it is provided here as a suggestion for parties to consider for a future effort if needed. The suggested methods include identifying suitable salinity areas given CEPP and other project results, then removing muck in those areas as described in Indian River Lagoon South project document.
- **The following options are specific to SAV and oysters**:
    - SAV- If there is an issue with water quality: provide the results as feedback to the implementing agencies to further optimize water quality using IRL-South Stormwater Treatment Areas, water quality features and State water quality projects/BMPs. If there is an issue with lack of seed source: Implement seagrass plantings, which may be a non-implementing agency restoration effort.
    - Oysters - If there is an issue with lack of oyster substrate: Add suitable substrate such as oyster cultch (material such as oyster shells or concrete laid down on oyster areas to provide mobile oyster spat with places to attach), or add mature oysters to increase spat production as described in the Indian River Lagoon South project.

1.4.1.4 Caloosahatchee Estuary

After implementing the CEPP Flow Equalization Basin (A-2 FEB), restoration performance will be monitored related to improved salinities in the Caloosahatchee Estuary due to reduction of high flows at S-77 (from LO) and S-79, which is the main structure that discharges into the Caloosahatchee River and Estuary (CRE). We are uncertain that the FEB will improve LO high flow releases during the wet season to the degree necessary to reduce low salinity events in the middle and lower estuaries that stress both SAV and oysters in the Caloosahatchee. In addition, we are uncertain about whether water quality and sedimentation in the Caloosahatchee will improve from existing LO flows that stress SAV photosynthesis.

Two primary indicators (SAV, oysters) will be used as multiple lines of evidence to verify ecological restoration response to improve salinities. Information will feedback into improved operations of the A-2 FEB in coordination LO and C-43 project, as well as future CERP increments related to storage to further reduce high flows. In addition, the monitoring will confirm whether water quality (nutrients) and/or sedimentation (total suspended solids) may be affecting restoration performance, which would need to be addressed by future CERP increments and State water quality best management practices. While it is possible that other factors could affect the estuaries and would not be identified by monitoring SAV and oysters there is a need to focus on a relatively small number of ecological indicators in order to be able to set targets and track change efficiently; therefore the valued ecosystem component (VEC) concept is used. For the uncertainties addressed in this adaptive management Plan the VECs are SAV and oysters, which have long been recognized as supporting estuarine habitat in these estuaries and have extensive historical data sets. Salinity is a primary indicator of the effects of fresh water flow changes, which help mediate extreme salinity fluctuations for oysters and SAV.

C-43 is an important CERP project that works synergistically with CEPP to improve high and low freshwater flows from the basin and Lake Okeechobee, and also addresses associated sediment and nutrient inputs from the basin, thus reducing stress on both SAV, and oysters. If that project is not implemented, the benefits to SAV (acreage and shoot density) and oysters (increased density per acre) associated with CEPP may not be realized. If C-43 reservoir is operational before the A-2 FEB, then RECOVER and CEPP baseline monitoring would document the changes due to that project to differentiate from changes resulting from CEPP.

CEPP Adaptive Management Uncertainties in the Caloosahatchee Estuary: There is a group of closely-related ecological uncertainties in the Caloosahatchee Estuary.

- Do reductions of high volume fresh water discharges result in measurable increases in SAV coverage and oyster acreage and health in the Caloosahatchee estuary? (ID#2)
- Will the reduction in low flow violations in the Caloosahatchee estuary help re-establish persistent *Vallisneria* beds in the upper Caloosahatchee estuary? (ID#49)

This group of uncertainties is related to the CEPP objective of reducing high volume discharges from Lake Okeechobee to the northern estuaries. The region is Lake O – northern estuaries. The associated CEPP and non-CEPP features are Lake O operations, the FEBs, S-77, and S-79.

What is expected to be learned by addressing this uncertainty, i.e., how will CEPP benefit from addressing this uncertainty? CEPP benefits to the Caloosahatchee estuary can be optimized if sufficient information about the on-the-ground effects of CEPP on the estuaries is gathered and reported.

Expectations and hypotheses to be tested to address the Caloosahatchee Estuary uncertainties, and attributes that will be measured to test each. The following hypotheses and performance expectations are supported by the modeling results reported in the RECOVER System-wide Evaluation of CEPP Report (**Annex E**). The proposed monitoring will leverage and compliment RECOVER northern estuaries monitoring and other project-level monitoring. The locations of CEPP-specific monitoring proposed here will be conducted in the specific locations where CEPP planning modeling showed effects from CEPP.

A. Flows (pertains to uncertainty #49)

- High flow reduction (>2800 cfs): 16.4% chance to 13.8% chance over existing conditions (94 to 68 high flow >2800cfs at S-79 over 41 year period of record).
- Low flow exceedence reduction (<450cfs): From 23.5 % chance to 5.3% chance over existing conditions (116 to 26 months of flows lower than 450 cfs over a 41 year period of record)

B. Salinity (pertains to uncertainty #2)

- CEPP will result in a greater percentage of time that the preferred salinity range of 16-28 psu at Cape Coral is met (increase from 37.7% to 45.3%), based on planning modeling results.
- CEPP will result in a greater percentage of time that the preferred salinity range of 16-28 psu at Shell Point is met (increase from 57.4% to 66%).

C. Submerged Aquatic Vegetation (SAV) (pertains to uncertainties #2, 49)

- Increase # of shoots per acre density in middle to lower estuary measured by Shell Point from 1,165,536 shoots per acre to 1,250,523 shoots per acre or 15.3% increase.
- CEPP will result in a decrease number of die off events and increase in Tape Grass acreage, shoot density, and blade length in upper estuary as indicated at Ft. Myers.

E. Oysters (pertains to uncertainty #2, 49).

- CEPP will result in an increase in oyster density at Shell Point by 4.4% from (3,893,214 oysters per square meter to 4,063,168).
- CEPP will result in an increase in oyster density at Cape Coral by 7.1% from (2,671,020 to 2,861,229 oyster per square meter).

More Information on Attributes to be measured:

- **What is expected to be learned by measuring this attribute, i.e., how will CEPP benefit from knowledge gained about this attribute?** The attributes have been identified as indicators of ecological health in the northern estuaries and indicators of restoration performance. They are the minimal efficient attributes to monitor CEPP performance in the estuaries.
- **What is the time frame in which changes to this attribute are expected to be measurable?** See triggers and thresholds below.
- **Is this attribute complimented by other monitoring programs (within and/or outside of CEPP)?** The monitoring is complimented by RECOVER MAP and restoration project monitoring. The locations for CEPP monitoring are focused in areas where CEPP modeling showed the most likelihood to achieve restoration benefits in the Caloosahatchee Estuary.
- **When during CEPP's life cycle should this monitoring begin?** If pre-CEPP estuarine monitoring can be used for baseline comparison, this monitoring should begin when CEPP changes flows to the estuaries by routing water to the FEB complex and Everglades rather than discharging it to the estuaries.

Methodology for testing each expectation or hypothesis (include frequency of monitoring). Hypotheses will be tested by measuring a reduction in high flows at S-79, after implementing the A-2 FEB and Lake O CEPP operations changes; some reviewers have noted that this may be the primary CEPP adaptive management indicator to monitor in the Caloosahatchee Estuary. Restoration performance related to two species of SAV and oysters will be measured to provide multiple lines of evidence of ecological response due reduction of high flows (oysters, manatee grass, and *Halodule* in middle to lower estuary) and reduction in low flow exceedences (*Vallisneria*). Baseline monitoring will be compared to monitoring when the A-2 FEB and Lake O operations are fully implemented. Information will feedback into improved operations of the A-2 FEB in coordination with Lake O and C-43, as well as future CERP increments related to storage to further reduce high flows. In addition, the monitoring will confirm whether water quality (nutrients) by future CERP increments and state water quality best management practices.

How results will be reported, and the triggers/thresholds that indicate good CEPP performance or need for adaptive management. Flows and Hydrology: Basin, Lake Okeechobee and S-79 flows will be measured to confirm progress towards expected CEPP performance. Rainfall in Kissimmee, LO, and C-43 basin will need to be considered to determine whether two consecutive water years are similar to baseline water years to compare performance improvements against. In addition, baseline monitoring (before project implementation) will be compared to flows achieved 2 years after CEPP and Lake O operations are implemented. Flows will be measured at S-79 and S-77. Salinity at Ft Myers, Shell Point, and Cape Coral will be monitored using existing networks.

SAV and Oysters: SAV and oysters will be measured after a minimum 4 year period of flows and salinity expected performance being achieved. Results will be compared to baseline and analyzed for incremental progress towards CEPP expected performance for both indicators (SAV and oysters). RECOVER SAV monitoring will be used (same protocol for quadzilla mapping at stations 1 and 2 for *Vallisneria*). The CEPP target indicates the first area downstream of S-79 where *Vallisneria* is most likely to reestablish is from 15 to 19 miles upstream from Shell Point. RECOVER oyster monitoring at Iona Cove, Cattle Dock, Bird Island, and Kitchel Key will be used. CEPP should increase frequency of oyster sampling from 2 to 4 times per year to better understand annual and inter-annual variation. RECOVER should continue predation and disease monitoring to better understand when oyster die-off events may be occurring to inform operations (to reduce disease and predation). Nutrients and total suspended solids will be compared in the same 4 year period to ensure these factors did not get worse from baseline. If salinity expectations are met with CEPP but SAV and oyster performance is not, there could be an issue with nutrients or total suspended solids preventing proliferation of these species, which would clarify needs and opportunities for future projects and thus prevent misdirection of future efforts.

Management options that may be chosen based on results. The following management options may be considered if expected flow and salinity performance and the subsequent ecological benefits are not realized:

- **If there is an issue with flows:** Optimize flows between C-43, Lake Okeechobee, the FEB complex, other projects as appropriate, and CEPP.
- **If there is an issue with sediment**: The CEPP Plan may reduce sediment loads to the estuaries by reducing water discharge volumes. However the Plan does not otherwise include provisions to improve estuarine substrate that is an important aspect of estuarine habitat. Evaluate benthic monitoring results as first indicator of issues with sediment. If results suggest that despite salinity improvements the ecological restoration is hindered by undesired sediment (potentially high organic, anoxic, high sulfide muck) then muck removal may be needed. Muck

removal is not part of the CEPP Plan nor has it been evaluated during CEPP planning; it is provided here as a suggestion for parties to consider for a future effort if needed. The suggested methods include identifying suitable salinity areas given CEPP and other project results and then removing muck in those areas, as described in Indian River Lagoon South project document.

- **The following options are specific to SAV and oysters**:
  - SAV- If there is an issue with water quality: provide the results as feedback to the implementing agencies to further optimize water quality using water quality features and State water quality projects/BMPs.

Oysters - If there is an issue with lack of oyster substrate see suggestions for future restoration projects included in the management options matrix (Table D.1.4).

O	Time until changes are measurable	Indicator or Attribute	Specific property to be Monitored, and Frequency	Decision Criteria: Confirmation of CEPP Performance or Trigger(s) for Management Action	Management Action Options
1, 45, 46	5 year	Flows	• Total flows into the St. Lucie Estuary at S-80, 49, 48, and Gordy Road	• After 5 years of operation, evaluate the 5 years of flow data to determine if monthly average flows exceedences that were >2000 cfs were fewer (17% of time vs. 30%) (5 year snapshot until target is recognized)	Within approved Lake O schedule, and utilizing IRL-S, the FEB capacities, and other projects as appropriate, examine whether adjustments can be made to further optimize flows and meet low flow needs and reduce high flows. **Potential considerations for future CERP and non-CERP restoration projects:** Increase water storage capability to continue to restore lower volumes of fresh water discharges to the estuaries; muck removal to improve substrate; if there is an issue with lack of SAV seed source implement seagrass plantings (may be non-implementing agency effort); if there is inadequate of oyster substrate add suitable substrate such as oyster cultch (material such as oyster shells or concrete laid down on oyster areas to provide mobile oyster spat with places to attach); add mature oysters to increase spat production as described in the Indian River Lagoon South project.
1, 45, 46	5 year	Salinity	• Salinity at US 1 bridge	• After 5 years of operation, evaluate the 5 years of flow data and see if % of time within 12 – 20 psu increased from 32-36%, and % of time below 12 psu decreased from 50 to 40 %.	
46	5 years	Benthic	• Benthic fauna at total 14 stations compared to 2 south fork stations (M-4 and M-5)	• After 5 years of operation and evidence of ideal flows and salinities met, Marine Benthic Index should move from Moderate (orange) to Good (green) at site M4; and Good (green) to High (blue) at site M5	
45	5 years	Oysters	• Oyster live-dead counts to four times a year (April, June, October, January); monthly monitoring samples for recruitment, growth, predation, and disease at existing locations.	• After 5 years of operation and evidence of ideal flows and salinities met, oyster density per acre should increase by 14% (574,674 to 655,614). If not, • Check for decreasing oyster recruitment, growth, predation, and disease trends	

1	5 years	SAV	• 4 or 5 stations same as RECOVER technique, SAV shoot density and species. Compare North to South Fork and Mid estuary. • Mapping of SAV acreage in St. Lucie every 2-3 years. • Continue monitoring and assessment of water quality data	• After 5 years of operation and evidence of ideal flows and salinities met, SAV shoot density per acre should increase by 20.1% (1,873,761 to 2,250,132). • If flows and salinity expectations are met but SAV does not improve, then check water quality results that may impact SAV growth and recruitment.	

Table D.1.4: St. Lucie Estuary Management Option Matrix

Table D.1.5: Northern Estuaries – Caloosahatchee Management Options Matrix

Uncertainty ID	Time until changes are measurable	Indicator or Attribute	Specific Property to be Monitored, Location, Frequency	Decision Criteria: Confirmation of CEPP Performance or Trigger(s) for Management Action	Management Action Option
#2, 49	5 years	Flows	• Structure flows into the CRE at S-79	• After 5 years of operation, evaluate the 5 years of flow data to determine if average monthly low flows (<450cfs) decreased from 23% to 5% of time (5 year snapshot until target is recognized)	Within approved Lake O schedule and utilizing C-43 and the FEB capacities, and other projects as appropriate, examine whether adjustments can be made to improve flows. **Potential considerations for future CERP and non-CERP restoration projects:** Same as those for the St. Lucie Estuary.
#2 and 49	5 years	Salinity	• Salinity (PSU) at Shell Point (*Halodule* and oysters), Ft. Myers (*Vallisneria*, and Cape Coral (15 minute sampling)	• After 5 years of operation, the desired range of salinity (16-28 psu) should be met 66% of the time (9% improvement over existing conditions) at Shell Point, and 45% of the time (8% improvement over existing conditions) at Cape Coral.	
#2 and 49	5 years	Oysters	• RECOVER oyster monitoring sites at Iona Cove, Cattle Dock, Bird Island, and Kitchel Key. Oyster density per square meter, oyster growth, disease and predation. Quarterly sampling.	• After 5 years of operation, oyster shoot density per meter squared should increase by 4.4% at Shell Point and 7.1% at Cape Coral. If not, examine oyster disease, predation monitoring.	
#2 and 49	5 years	SAV	• RECOVER SAV monitoring for seagrass shoot density and species coverage. • SAV acreage mapping every 5 years	• After 5 years of operation, increase seagrass shoot density (*Halodule*) per acre by 15.3% at Shell Point. • After 5 years of operation, reestablish *Vallisneria* beds 15 to 19 miles upstream of Shell Point. • If flows and salinity expectations are met but SAV does not improve, then check water quality results that may impact SAV growth and recruitment.	

1.4.2 Greater Everglades Strategies and Management Options

A large portion of CEPP's area consists of the central Greater Everglades, including Water Conservation Area 3A (WCA 3A), Water Conservation Area 3B (WCA 3B), and the inland portion of Everglades National Park (ENP). The hypotheses, questions, uncertainties and management options below focus on CEPP's expected improvement of the ecological condition of the Everglades in terms of geo-morphological features, water flow, peat depths, vegetation, fire reduction, and fundamental prey and predator interactions. Over 15 years of scientific work, interagency collaboration, and public involvement have elevated these Everglades features to the forefront based on ecological and social values. The CEPP-specific questions were identified based on expected improvements from CEPP features and operations. Several topics were honed during the development of the Adaptive Management Plan based on the availability of information to create a detailed adaptive management strategy, for example, while several bird species are important in the Everglades the focus in this Plan is on Spoonbills and Wood Storks due to the availability of nest success performance measures for these species; other species' performance measures focus on nest numbers which is not as informative for the needs of this Adaptive Management Plan. It should be noted that several of the questions below begin with "How much…" and these topics were also honed to focus on indicators or species for which there is enough scientific understanding to estimate a target with upper and lower bounds. The estimations are described in each "Adaptive Management Strategy". It is recognized that some estimations need refinement as data is collected and understanding of the Everglades ecosystems continually improves.

As noted above, adaptive management will be reiterated in the coming phases of CEPP, and the Adaptive Management Plan will be revisited. At such time, more baseline data and lessons learned will be available from other monitoring programs and restoration projects. Given the new knowledge, key questions and adaptive management options proposed in this Plan may need refinement. Therefore, items included in this plan are not guaranteed to be included or funded as-is, but will be considered again when CEPP is closer to being implemented.

1.4.2.1 Scope of Greater Everglades Adaptive Management Monitoring Plan

This scope is summarized in the following five figures (Figure D.1.5-Figure D.1.9).

The Adaptive Management Strategy for CEPP in the Greater Everglades

- **Focus the science in the areas where CEPP modifications are expected to have the greatest impacts and across ecotones.**
- **Design sampling to optimize RECOVER and Compliance monitoring networks.**
- **Sequence elements of the AM Plans with construction.**

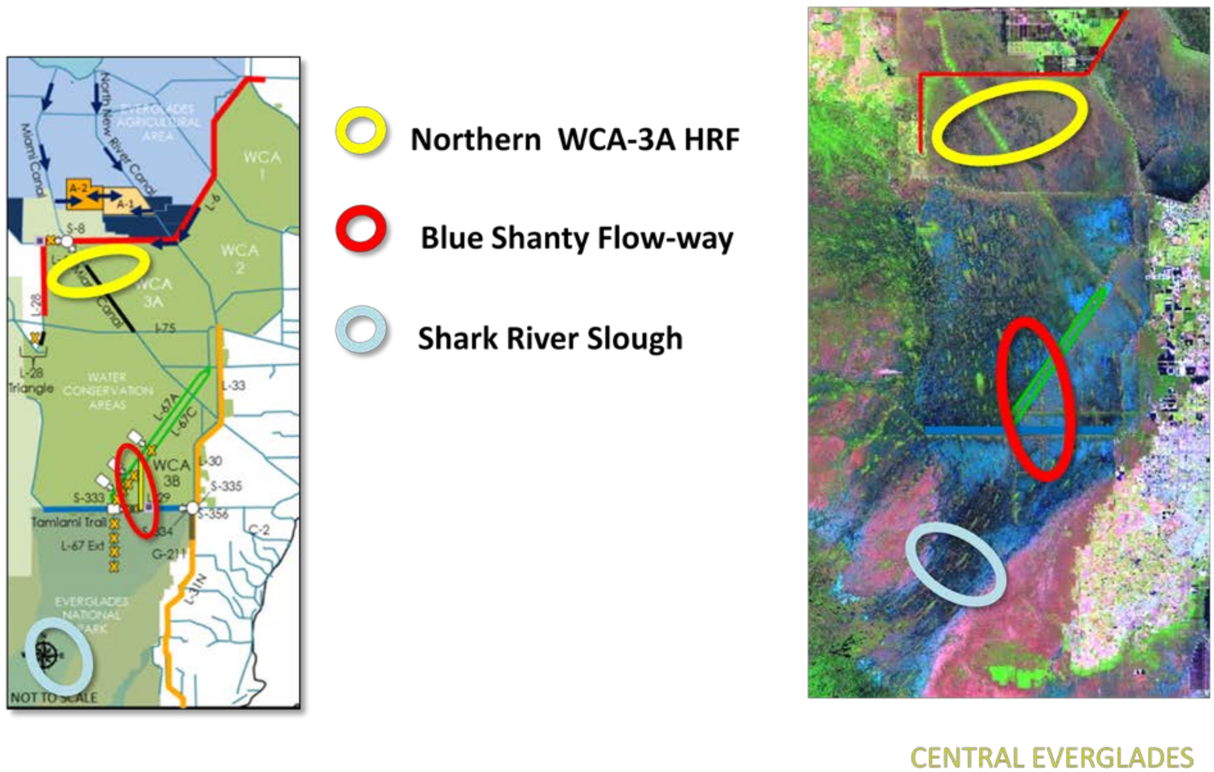
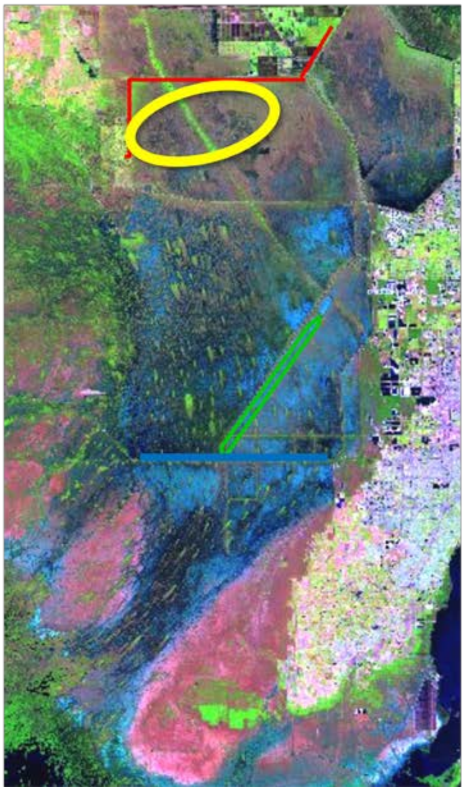


Figure D.1.5: The scope of the Greater Everglades adaptive management plan is focused on regions where the most hydrologic alterations are expected, and each major element of this adaptive management Plan can be summarized into four figures (See below).

Figure D.1.6-Figure D.1.8 below summarizes the "Direct-Effects" adaptive management program downstream of each of the three major control structures associated with CEPP; 1) The NW-WCA-3A Hydropattern Restoration Feature (HRF), 2) The Blue Shanty Flowway and 3) The Tamiami Trail Bridges (Central SRS). Figure D.1.7 summarizes the "Indirect-Effects" adaptive management program in regions with relatively long lag times and/or are regions far removed from the direct impacts of major new structures within the Greater Everglades. *Although exact sampling protocols and frequencies will be developed during CEPP's detailed design phase, the costs associated with these adaptive management strategies are relatively correct, are indicative of the proportional efforts that will be expended to address attribute specific methodologies, and most importantly, assumes that all hydrologic and ecological monitoring associated with RECOVER, USGS and the ENP remain at current (i.e., FY2013) funding levels.*

The GE Adaptive Management Strategy for CEPP

Northern WCA-3A HRF -- $485,000

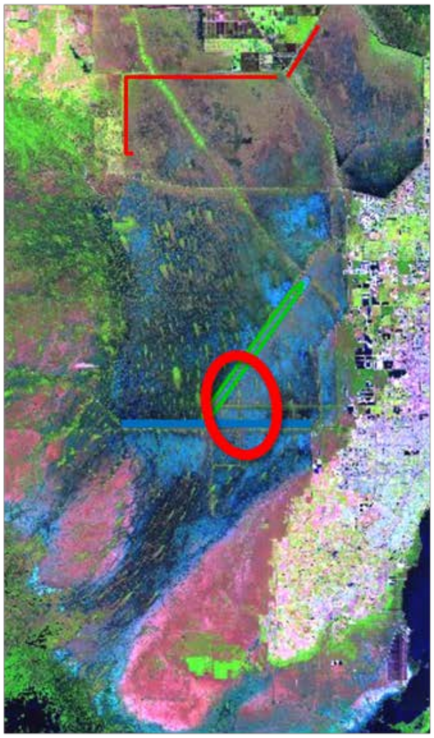


# - Uncertainty	Attributes to be Monitored	1-yr Costs
#5 - Will CEPP reduce soil oxidation and peat fires?	*Soil Moisture Content; Peat Accretion; Fire mapping; Community Structure; Radiometric Dating; Soil Decomposition; Weather; Hydrology*	$100,000.00
#63 & #76 - Will CEPP hydrology and biogeochemical response reestablish ridge, slough and tree islands?	*Tree islands, Canals and Marsh: Soil dynamics, Periphyton, WQ, Vegetation Mapping*	$250,000.00
#9 - How much will hydrologic restoration and vegetation management in result in increases in prey densities (aquatic fauna).	Aquatic fauna density; Large fish density	$50,000
#10 & #75 - How much will CEPP improve terrestrial wildlife and alligators?	Alligator relative density and body condition; Deer abundance; Terrestrial animal diversity	$85,000

Figure D.1.6: Elements of the Hydrologic Restoration Feature (HRF) will focus the Adaptive Management monitoring in the NW section of WCA-3A. Some of the uncertainties have been combined for tabular simplicity. The uncertainties are mostly related to the complete lack of ridge and slough vegetation, microtopography, fish and wading birds in this region. Here the question is: Can the construction and operation of the HRF facilitate a healthier landscape that will support a return of typical Everglades foodwebs? This wetland is strongly sloped from west to east and flows will need to be re-directed more north to south as part of CEPP. Adaptive Management options that create preferential flows paths, scour out deeper sloughs, remove cattail or that thin out dense willow plains will be considered for evaluation.

The GE Adaptive Management Strategy for CEPP

Blue Shanty Flow-way -- $515,000

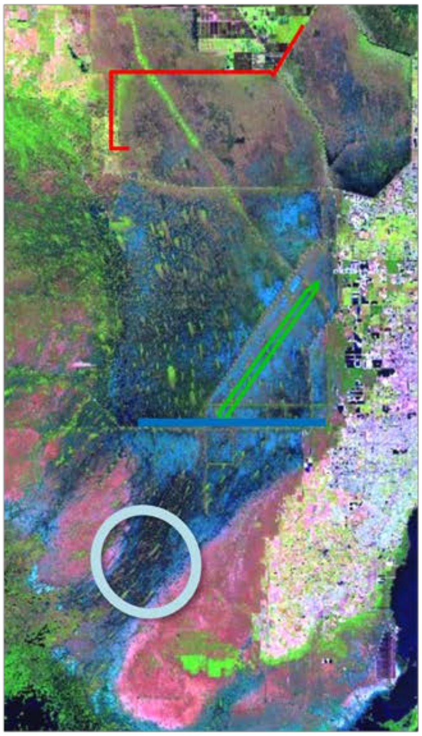


# - Uncertainty	Attributes to be Monitored	1-yr Costs
#5 - Will CEPP reduce soil oxidation and peat fires?	*Soil Moisture Content; Peat Accretion; Fire mapping; Community Structure; Radiometric Dating; Soil Decomposition; Weather; Hydrology*	$50,000
#63 & #76 - Will CEPP hydrology and biogeochemical response reestablish ridge, slough and tree islands?	*Tree islands, Canals and Marsh: Soil dynamics, Periphyton, WQ, Vegetation Mapping*	$425,000
#9 - How much will hydrologic restoration and vegetation management in result in increases in prey densities (aquatic fauna).	Aquatic fauna density; Large fish density	$25,000
#10 - How much will CEPP improve alligator relative density and body condition?	Alligator relative density; Alligator body condition	$15,000

Figure D.1.7: Elements of the control structures on the L-67A levee, the removal of some of the L-29 levee and the 2.5 Mile Bridge on Tamiami Trail in WCA-3B will determine the focus of the Blue Shanty Flowway Adaptive Management monitoring. Some of the uncertainties have been combined here for tabular simplicity. The uncertainties are mostly related to flow rates needed to create ecological connectivity, while restoring tree islands, slough vegetation and microtopography. Here the question is: How well will the operations of the L-67A structures reconnect WCA-3A to ENP, rehydrate WCA-3B and create a healthy ridge & slough landscape? Adaptive Management options that create preferential flows paths, scour out deeper sloughs, and pulse flow velocities across the flowway are all available for evaluation.

The GE Adaptive Management Strategy for CEPP

Shark River Slough -- $360,000

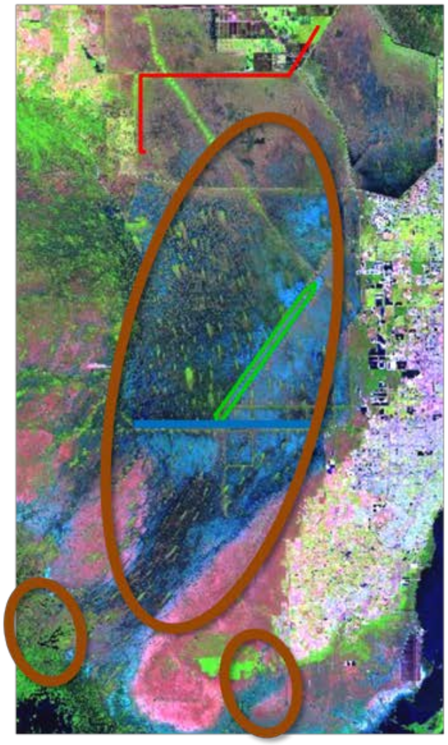


# - Uncertainty	Attributes to be Monitored	1-yr Costs
#5 - Will CEPP reduce soil oxidation and peat fires?	*Soil Moisture Content; Peat Accretion; Fire mapping; Community Structure; Radiometric Dating; Soil Decomposition; Weather; Hydrology*	$100,000
#63 - Will Biogeochemical response be altered by changes in the timing and distribution of CEPP hydrology?	*Tree islands, Canals and Marsh: Soil dynamics, Periphyton, WQ, Vegetation Mapping*	$150,000
#9 - How much will hydrologic restoration and vegetation management in result in increases in prey densities (aquatic fauna).	Aquatic fauna density; Large fish density	$20,000
#10 - How much will CEPP improve alligator relative density and body condition?	Alligator relative density; Alligator body condition	$15,000
#61; #73 & #76 - Will CEPP hydroperiods, depths and flow velocities reestablish ridge and slough landscapes, including tree islands?	Tree Island Attributes (Peat Accretion, Soil Nutrients, Community Structure, GW flows); Ridge & Slough Attributes (Community Structure, Floc analysis, periphyton, sediment movement, flow velocities)	$75,000

Figure D.1.8: Management of features along Tamiami Trail (S-333, S-356, and the divide structure) will be the focus of the Adaptive Management monitoring plan for Shark River Slough (SRS). Some of the uncertainties have been combined for tabular simplicity. The uncertainties are mostly related to the hydrologic connectivity of SRS to adjacent habitats (e.g., Rocky Glades), tree islands, wading birds and Florida Bay. Here the question is: How will the distribution of flow in Northeast SRS (i.e., the 1-mile bridge vs. the 2.5 mile bridge) restore tree islands, prevent soil oxidation, and enhance fish densities for wading birds? The hydrology of SRS can affect the ecology of adjacent habitats (i.e., Rocky Glades, the wet prairies of the Cape Sable Seaside Sparrow (CSSS) and Florida Bay). Therefore the Adaptive Management options that expand the SRS habitat, increase hydroperiods where wading bird are expected to forage, and reduce Florida Bay salinities, while allowing wet prairie habitat to be maintained or transition to new areas, will be considered for evaluation.

The GE Adaptive Management Strategy for CEPP

Far afield -- $370,000



# - Uncertainty	Attributes to be Monitored	1-yr Costs
#63 & #64 - Will CEPP mitigate saltwater intrusion effects on coastal wetland vegetation , soil, and nutrient retention or release?	*Changes in saltwater intrusion extent, salinity, vegetation, soil nutrient and carbon dynamics (SRS, Taylor Slough, Mangrove wetland, nearshore Fl Bay)*	$175,000
#61 and #67 - Will CEPP improve coastal salinity patterns, resulting in improved habitat and food webs	*Coastal wetland and nearshore food web analysis and modeling (SRS, Taylor Slough, Mangrove wetland, nearshore Fl Bay)*	$75,000
#65 & #75 - How much will hydrologic restoration and vegetation management result in increases in wading bird foraging conditions?	Prey availability, model refinement Northern WCA-3A, Blue Shanty, WCA-3B, SRS, Fl Bay	$120,000

Figure D.1.9: The combination of all three GE Adaptive Management Strategies will indirectly impact habitats and foodwebs far from the new structures in CEPP. These far-afield uncertainties have the potential to influence decision-making, management options and CEPP II design. The overriding uncertainty is the degree of restored water volumes and its adequacy in terms of large scale, landscape restoration. Here the question is: How close to full scale CERP restoration does the additional 210,000 acre-ft associated with CEPP bring the Everglades? Adaptive Management options are all those associated with the NW-WCA-3A HRF, the Blue Shanty Flowway and the Tamiami Trail Bridges. Some of the uncertainties have been combined for tabular simplicity.

1.4.2.2 Flow Velocity for Ridge and Slough

CEPP Adaptive Management Uncertainty #73: Are the flow velocities, flow direction, volumes of fresh water, and water depth improvements from CEPP sufficient to reestablish historic ridge and slough landscapes? (Driver or uncertainty type: Hydro-ecological)

This uncertainty is related to the CEPP objective of restoring a natural mosaic of wetland habitats in the Everglades system, and relates to all regions and features of CEPP, but is most specific to regions immediately downstream of major restoration features. These features include the HRF Spreader Canal in NW WCA 3A, the Blue Shanty flowway in WCA 3B and project features and operations that move water under the two Tamiami Trail bridges.

What is expected to be learned by addressing this uncertainty, i.e., how will CEPP benefit from addressing this uncertainty?

This critical uncertainty directly impacts the sustainability of the ridge/slough landscape and the ability of CEPP to redistribute sediments, alter peat oxidation rates, prevent peat fires, produce microtopography and create the diversity of habitats needed by the plant and animal communities of the Everglades. The flow velocities in the direction of historic sloughs and ridges, water volumes, and water depths downstream of new CEPP inflow structures are expected to enhance the transport of slough bed particles, periphyton-derived particles, and water column-derived particles. According to the ecological theory of Dynamic Equilibrium, the creation of historic transport conditions will restore historic depths of sloughs and elevation of ridges.

Expectations and hypotheses to be tested to address uncertainty, and attribute(s) that will be measured: Central to this uncertainty is the hypothesis that historic flow velocities, directionality, and volumes will restore historic depths of sloughs and elevation of ridges. This uncertainty will be evaluated in three separate regions of the Greater Everglades (NW WCA 3A, Blue Shanty Flowway and central SRS), but not at the same time. As a result, findings from the region that is restored first will impact adaptive management strategies to follow. Also, sediment transport models such as RASCAL (Ridge and Slough Cellular Automata Landscape) (Larsen and Harvey 2010) will provide insight for future refinement of modeling needs. Specific attributes and expectations include:

Hydrology:

- Velocity – Pulsed velocities reaching 2.5 cm/second or greater in downstream marsh of HRF, L-67, and Tamiami Trail Bridge structures for a total of 4 weeks during average and wet years.
- Direction: Mimic historic slough and tree island directionality.
- Volume: 210,000 acre-ft (long-term annual average) of additional water delivered to Northern WCA 3A.
- Depth – Decrease in the times that water depths go negative (i.e., below ground surface) by 120 days per year, on average in NWCA 3A, by 160 days per year, on average in WCA 3B, and by 210 days per year, on average in Northeast Shark River Slough.

Sediment:

- Organic – sediments will accumulate quicker in regions with long hydroperiods and will be redistribution in regions with periodic high flow velocities to create preferential flow paths and historic slough landscapes.

Vegetation:

- Northwestern WCA 3A – woody herbaceous vegetation will restore to ridges of sawgrass and sloughs with water lily south of HRF feature and along the backfilled Miami Canal.
- In SRS – expansion of ridge and slough pattern along the edges of SRS.
- WCA 3B – sawgrass meadows will transition to sawgrass ridges and water lily sloughs, while maintaining tree islands.

Quantification of the distribution, subsidence, accretion and movement of sediments, floc and peat is required to understand the role of flow velocities, direction, volumes, and water depth on the restoration and maintenance of healthy sloughs and ridges. The flow velocities, direction, volume, and water depth will be measurable immediately upon implementation of the CEPP structures; entrainment and transport of particles should also be measurable quickly. Re-creation of slough-ridge patterns that can be validated by surveys of peat elevations and vegetation structure will take at least 5-10 years to measure but will have some early indicators via measurements of water and sediment movements.

Methodology for testing each expectation or hypothesis: A BACI (Before-After-Control-Impact) methodology will be used for testing expectation everywhere in the Greater Everglades and for all hypotheses. In this approach, the before period is defined by measurements made 2-3 years prior to the impact (e.g., operation of the Blue Shanty gated culverts) and the after as the period during and following pulsed flow events. Control and impact reflect the regions not influenced and influenced by the structures and features, respectively. The monitoring will use a multidisciplinary approach that directly couples the monitoring of hydrology, sediment transport, vegetation, and wildlife (and, thus multiple hypotheses). The central focal points of the monitoring will be the detailed description of the hydrologic flow fields in the region of the structures and features, and the environmental conditions of the downstream communities. Monitoring shall use well-established vegetation and biogeochemical methods and state-of-the art tracer technologies when appropriate. The detailed plans for these measurements and QA/QC protocols will be described in more detail after CEPP authorization. Further evaluation will be gained by integrating field results with simulation (e.g., Ribbon and Lattice-Boltzmann) and hydrologic models (e.g., SFWMM). Based on lessons learned from RECOVER Monitoring and Assessment Plan and Decomp Physical Model landscape monitoring, attribute-specific methodologies will include:

- Hydrology: Hydraulic gradient will be expressed as “flow fields” that describe the movement of surface flows. Surface-water flow fields will be defined using a grid of continuous measurements of water level (e.g., stage gages and pressure transducers), a selected number of continuous velocity measurements, and point velocity measurements (e.g., Acoustic Doppler Velocimeter, ADV). Stage (water depth) data will be operated and maintained using USGS and/or SFWMD-established protocols. The large-scale hydrodynamics of surface water flows will primarily be investigated using an SF6 tracer methodology modified for the low-gradient Everglades. Concomitantly, dye tracer releases will be made to visually assess local flow patterns. The results of the tracer tests, in combination with aerial photography to delineate spatial features, will be integrated with a Lattice-Boltzmann modeling procedure to develop fine-scale simulations of flow dynamics within the ridge & slough landscape, including vegetation interactions.
- Vegetation: The hydrologic monitoring process will serve as a framework for conducting a large number of location-specific measurements on particle sources, physical characteristics of particles, particle mass-balance relationships, and associated vegetation characterizations. It is anticipated that novel or state-of-the art technologies will be employed to characterize these phenomena. It is expected that methodologies will differ between the canal and marsh studies. Relationships between the hydrological attributes and the slough-ridge sediment and vegetation will be determined by measuring peat depths, elevations, soil nutrients and vegetation productivity along north-south transects in WCA-3 and west-east gradients in SRS within GRTS sampling units. The Generalized Random-Tesselation Stratified approach (GRTS) of Stevens and Olsen (2004)), drawn from a tiling of the Ridge and Slough and sawgrass prairie areas into 2km * 5km cells oriented along the directions of ridges, is a probability design, allowing design-based estimates of regional means. It provides spatial balance for inferences about gradients of change, and for model-based inferences (spatial interpolation) of regional means. It supports varying spatial and temporal measurement intensity for different attributes while maintaining co-location for inferences about causal pathways. Thus, it maximizes the flexibility of subsequent analyses of the resultant monitoring data. Changes over time will include comparisons with historic aerial photographs. The detailed plans for these measurements and protocols will be described in more detail after CEPP authorization.

How results will be reported and the triggers/thresholds that indicate good CEPP performance or need for adaptive management action: The BACI statistical design will be used to formulate conclusions, address the uncertainties and make recommendations. Results will be provided on an annual basis to CEPP Project Managers, agency leads and the general public as part of the SFER (South Florida Environmental Report). Conclusions and recommendations for adaptive management actions will be provided every 2-3 years after integration with monitoring results from RECOVER, CEPP (non-adaptive management), and other agencies (non-CEPP) such as USGS, EPA, FWS, etc. This integration, reported by RECOVER, will evaluate the triggers/thresholds that indicate good CEPP performance based upon established and approved RECOVER Performance Measures. Examples include; 1) timing and amplitude of water depth fluctuations, 2) water flow direction and magnitude, 3) sediment transport patterns, 4) ridge and slough functionality, connectivity and aligned with ridges.

The process to establish and recommend an adaptive management action will be more complicated than simply reporting because it will be constrained by: 1) requirements of the BACI approach, 2) the size of the downstream testing environment, 3) the size of the new CEPP hydrologic structure, 4) the resilience of the downstream habitats (i.e., their ability or inability to change), 5) weather patterns, and 6) CEPP sequencing. RECOVER is designed to have the scientific and organization framework to manage this degree of complexity. With appropriate staffing, RECOVER will review the detailed adaptive management strategies, including but not limited to refined methods, frequencies, and logistics, for each of the three adaptive management downstream study areas (i.e., northeast WCA 3A, Blue Shanty Flowway and central SRS), for scientific focus, engineering practicality, field logistics and restoration relevance. Once an adaptive management study is implemented, and at least two years of post-construction data has been reviewed, RECOVER will evaluate results and may recommend staying with the methods or modifying them, or may suggest a new management action.

Management options that may be chosen to improve performance and assess the role of flow for ridge and slough restoration: Feedback to CEPP management could inform project decisions on timing, pulsing, or routing of water deliveries through an area differently than originally specified but within the approved CEPP Plan. Suggested adaptive management options listed below are not in any particular order and can be implemented simultaneously, as appropriate.

- Concurrent or series testing of vegetation management options (e.g., fire, harvesting, herbicide, physical stress) downstream of the NW-WCA 3A HRF and the 67A conveyance features to create preferential flow paths along historic flow paths.
- Increase operational flexibility to maximize flow velocities in the Blue Shanty flowway including; 1) hydrological pulsing, 2) fill, plug, or gap ditches and agricultural canals, 3) implement rest of L-67A conveyance features to test additional flow, 4) Spoil mound removal and vegetation clearing, 5) Backfill Blue Shanty North-South Canal.
- Incremental increases in inflows to WCA-3B to create sloughs.
- Adjust operations along the northern boundary of WCA 3A by redistributing water into the S8 or into a new HRF east of the Miami Canal.

1.4.2.3 Restoring Tree Island Hydrology

CEPP Adaptive Management Uncertainty #76: **Can CEPP create hydrology favorable for tree island elevation requirements?** (Driver or Uncertainty type: hydro-ecological)

This uncertainty is related to the CEPP objective of restoring a natural mosaic of wetland habitats in the Everglades system, and relates to the potential for longer hydroperiods throughout the Greater Everglades, but especially downstream of new control structures. Addressing this uncertainty should reverse processes of peat subsidence and habitat (vegetation) diversity loss on tree islands.

What is expected to be learned by addressing this uncertainty, i.e., how will CEPP benefit from addressing this uncertainty? The CEPP adaptive management monitoring plan expects to unravel the mechanisms of tree island restoration and sustainability in order to a) manage hydrological parameters (i.e., depth, hydroperiod, flow) downstream of major operational structures and b) promote ecological processes such as, peat accumulation and decomposition rates, vegetation diversity, seedling recruitment and tree growth rates. Expectations are very similar to those associated with the flow uncertainty above. That is, this uncertainty will evaluate the sustainability of the ridge/slough landscape and the ability of CEPP to redistribute sediments, decrease peat oxidation rates, prevent peat fires, produce microtopography and create the diversity of habitats needed by all plant and animal communities. According to the ecological theory of Dynamic Equilibrium, the creation of historic water depths and hydroperiods will restore historic tree island peat depths and plant diversities.

Expectations and hypotheses to be tested to address uncertainty, and attribute(s) that will be measured: Central to this uncertainty is the hypothesis that historic hydroperiods and water depths on pre-drainage tree islands created a dynamic steady state where islands were able to maintain elevations of 2-3 feet above the surrounding sloughs, had a diverse population of wetland hardwoods and were refugia for nesting and foraging wildlife during high water conditions. This uncertainty will be evaluated in three separate regions of the Greater Everglades (NW WCA-3A, Blue Shanty Flowway and central SRS), but not at the same time. As a result, findings from the region that is restored first will impact adaptive management strategies to follow. Specific attributes and expectations include:

- Hydrology:
  - Water Depth: Maximum annual water depths for tree islands with high soil oxidation rates, and as a result, low elevations, might increase by 100%. However, stress associated with high waters will be minimized if hydroperiods do not exceed 11 months.
- Sediments:
  - Peat: Accretion rates are expected to exceed soil decomposition and subsidence rates, causing entire islands to increase in elevation.
  - Biogeochemistry: Restoration will enhance the accumulation of phosphorus in tree island sediments.
- Vegetation:
  - Marsh vegetation: Increased density of herbaceous species, especially in the lower elevation tails.
  - Trees: Increased recruitment of woody vegetation everywhere, but especially on the higher elevation heads.

Methodology for testing each expectation or hypothesis: A BACI (Before-After-Control-Impact) methodology will be used for testing expectation everywhere in the Greater Everglades and for all hypotheses. In this approach, the before period is defined by measurements made 2-3years prior to the impact (e.g., operation of the Blue Shanty gated culverts) and the after as the period during and following pulsed flow events. Control and impact reflect the regions not influenced and influenced by the structures and features, respectively. The monitoring will use a multidisciplinary approach that directly couples the monitoring of hydrology, sediment characteristics, vegetation, and wildlife (and, thus multiple hypotheses). The central focal points of the monitoring will be the detailed description of the peat accretion rates and tree root development on tree islands downstream of new water control structures. Monitoring shall use well-established vegetation and biogeochemical methods. The detailed plans for these measurements and QA/QC protocols will be described in more detail after CEPP authorization. Attribute-specific methodologies will include:

- Geomorphology and Hydrology: Tree island soil characteristics, pore water chemistry, and elevation changes will be monitored in such a way as to relate tree island hydrology, soil moisture and surficial flow patterns to peat accretion, community structure, root production and pore-water nutrients. Islands downstream of control structures will outfitted across transects with Surface Elevation Tables (SETs), feldspar marker horizons, and shallow groundwater wells to monitor peat accretion rates, soil elevations, groundwater movement, and pore-water nutrients. Changes over time will include comparisons with historic aerial photographs.
- Vegetation: Relationships between the hydrological attributes and the slough-ridge sediment and vegetation will be determined by measuring peat depths, elevations, soil nutrients and vegetation productivity along north-south transects in WCA-3 and west-east gradients in SRS within GRTS sampling units. The Generalized Random-Tesselation Stratified approach (GRTS) of Stevens and Olsen (2004)), drawn from a tiling of the Ridge and Slough and sawgrass prairie areas into 2km * 5km cells oriented along the directions of ridges, is a probability design, allowing design-based estimates of regional means. It provides spatial balance for inferences about gradients of change, and for model-based inferences (spatial interpolation) of regional means. It supports varying spatial and temporal measurement intensity for different attributes while maintaining co-location for inferences about causal pathways. Thus, it maximizes the flexibility of subsequent analyses of the resultant monitoring data. The detailed plans for these measurements and protocols will be described in more detail after CEPP authorization.

How results will be reported, and the triggers/thresholds that indicate good CEPP performance or need for adaptive management action: The BACI statistical design will be used to formulate conclusions, address the uncertainties and make recommendations. Results will be provided on an annual basis to CEPP Project Managers, agency leads and the general public as part of the SFER (South Florida Environmental Report). Conclusions and recommendations for adaptive management actions will be provided every 2-3 years after integration with monitoring results from RECOVER, CEPP (non-adaptive management), and other agencies (non-CEPP) such as USGS, EPA, FWS, etc. This integration, reported by RECOVER, will evaluate the triggers/thresholds that indicate good CEPP performance. For tree islands, this will require the creation of a new suite of RECOVER Tree Island Performance Measures. Examples include; 1) timing and amplitude of water depth fluctuations, 2) soil accumulation rates, and 3) canopy cover and density.

The process to establish and recommend an adaptive management action will be more complicated than simply reporting because it will be constrained by: 1) requirements of the BACI approach, 2) the size and number of tree islands in the downstream testing environment, 3) the resilience of the downstream tree islands (i.e., their ability or inability to change), and 4) CEPP sequencing. RECOVER was designed to have the scientific and organization framework to manage this degree of complexity. With appropriate staffing, RECOVER will review the methodologies for each of the three adaptive management downstream study areas (I.e., NE-WCA-3A, Blue Shanty Flowway and central SRS), for scientific focus, engineering practicality, field logistics and restoration relevance. Once an adaptive management study is implemented, and at least two years of post-construction data has been reviewed, RECOVER will evaluate results and may recommend staying with the methods or modifying them, or may suggest a new management action.

Management options that may be chosen to improve performance and assess the role of hydrology for tree island restoration: Feedback to CEPP management could include informing project decisions such as timing of delivering water, pulsing of delivery water, managing FEB/STA water to either enhance or reduce tree island hydroperiods, or routing water through an area slightly differently than originally specified. Suggested adaptive management options for tree islands downstream of CEPP water control structures listed below are not in any particular order and can be implemented simultaneously, as appropriate. Some options that would need additional authorization to improve restoration beyond CEPP are presented in the management options matrix.

- Create moat-like sloughs around tree islands using vegetation management options (e.g., fire, harvesting, herbicide, physical stress) as tested in the Loxahatchee Impounded Landscape Assessment (LILA) Everglades ecological experiments.
- Increase operational flexibility to maximize flow velocities in the Blue Shanty flowway including; 1) hydrological pulsing, 2) implement rest of L-67A conveyance features for additional flow as described in the CEPP Plan, 3) vegetation clearing or management.
- Incremental increases to WCA-3B hydroperiods to create more resilient tree islands with higher elevations in anticipation of a future increment of CERP.
- Adjust operations along the northern boundary of WCA 3A by redistributing water into the S8.

1.4.2.4 Reducing Soil Oxidation and Fire

CEPP Adaptive Management Uncertainty #5: **Are inundation and hydroperiod sufficient to reduce current high rates of soil oxidation and peat fires?** (Driver or Uncertainty type: hydro-ecological)

This uncertainty is related to the CEPP objective to improve sheet flow patterns and surface water depths and duration in order to increase soil moisture to minimize muck fire events and loss of peat soils in the Everglades system. Furthermore, the hydrological restoration in CEPP will prevent peat fires in all regions and all habitats, and will reverse processes of subsidence, especially in Northeast WCA 3A, WCA 3B, the Rocky Glades, and eastern margin of SRS.

What is expected to be learned by addressing this uncertainty, i.e., how will CEPP benefit from addressing this uncertainty? Deep-burning peat fires generally occur during periods of extended drought when extreme burning conditions are generally occurring at a landscape level. Therefore, greater understanding of the effect surface water depth and duration on the combustion potential in organic soils will provide a useful tool for informing managers how to allocate more efficiently and effectively limited resources during periods of greatest demand. Thus, by addressing this uncertainty CEPP will help to reduce the frequency and intensity of muck fire events that will help to decrease soil oxidation and reduce potential damage to the plant community, in general, and woody trees in particular. Similarly, reduction of fire events will decrease the potential of shift in community composition from forested ecosystems to marshes as it has been observed in the ENP.

Expectations and hypotheses to be tested to address uncertainty, and attribute(s) that will be measured: Central to this uncertainty is the hypothesis that organic soil loss and accumulation is maintained in a state of dynamic equilibrium as a function of surface water depth and duration, water table and fire events. This hypothesis will be tested in three separate regions of the Everglades, including NW WCA-3A, WCB-3B and Central Shark River Slough. Specific attributes and expectations include:

Attributes:

a) Hydroperiod, flow velocity and direction, and water table depth;

b) Soil accretion rates by using sediment elevation tables (SETs) to document peat accretion rates on natural and created tree islands-link to tree islands (Note that SETs are only on tree islands, which is why SETs are associated with this uncertainty. Ridge and slough elevation changes will be measured in association with GRTS panels for other adaptive management uncertainties);
c) Belowground production and decomposition rates (standardized peat from different areas in the Everglades Protection Area will be used to decompose naturally at different rates due to the different organic matter matrices).
d) Soil moisture and soil bulk density;
e) Organic matter content of peat and percent organic carbon;
f) Microtopography peat depths and pore-water nutrients across landscape units. Porewater nutrients will be monitored to evaluate the stability of the total phosphorus concentrations and the potential for invasive/nuisance species to decline or increase with restoration.

Expectations:

a) Decrease frequencies and durations of dry outs leading to decrease rates of organic soil loss through oxidation and/or peat fires.
b) Increasing peat accumulation due to improving sheet flow.
c) Timing and distribution of water will reduce soil oxidation and fire events.
d) NW WCA 3A: fire frequencies should be reduced.
e) NE WCA 3A: HRF may not be sufficient to eliminate soil oxidation and threat of peat fires within NE 3A.
f) WCA 3B: peat fires will not occur within the Blue Shanty area but within northern 3B it is expected that fires will decrease by 20%.
g) Rocky glades: Fire will continue to occur as CEPP hydroperiods are not sufficient to reduce potential threat of fire and soil oxidation.

Methodology for testing each expectation or hypothesis: A BACI (Before-After-Control-Impact) methodology will be used for testing expectation everywhere in the Greater Everglades and for all hypotheses. In this approach, the before period is defined by measurements made 2-3 years prior to the impact (e.g., operation of the Blue Shanty gated culverts) and the after as the period during and following pulsed flow events. Control and impact reflect the regions not influenced and influenced by the structures and features, respectively. The monitoring will use a multidisciplinary approach that directly couples the monitoring of hydrology, sediment characteristics, and vegetation. The central focal points of the monitoring will be the detailed description of spatial and temporal patterns of soil moisture, soil bulk density and organic matter content that are directly associated with water table depths. Monitoring shall use well-established soil moisture and soil accretion methods. The detailed plans for these measurements and QA/QC protocols will be described in a Science Work plan, which will be developed after CEPP authorization. Attribute-specific methodologies will include:

- Hydrology: Soil characteristics, including soil moisture, organic matter content, and bulk density along with water table depths will be monitored in such a way as to relate hydrology and surficial flow patterns to frequency of dry-downs
- Soil: Relationships between the hydrological attributes and soil and vegetation processes will be determined by measuring peat depths, elevations, soil nutrients and vegetation productivity along north-south transects in WCA-3 and west-east gradients in SRS within GRTS sampling units. The Generalized Random-Tesselation Stratified approach (GRTS) of Stevens and Olsen (2004)), drawn from a tiling of the Ridge and Slough and sawgrass prairie areas into 2km * 5km cells oriented along the directions of ridges, is a probability design, allowing design-based estimates of regional means. It provides spatial balance for inferences

about gradients of change, and for model-based inferences (spatial interpolation) of regional means. It supports differing spatial and temporal intensity of measurement for different attributes while maintaining co-location for inferences about causal pathways. Thus, it maximizes the flexibility of subsequent analyses of the resultant monitoring data. The detailed plans for these measurements and protocols will be described in a Science Work plan, which will be developed after CEPP authorization.

How results will be reported and the triggers/thresholds that indicate good CEPP performance or need for adaptive management action: The BACI statistical design will be used to formulate conclusions, address the uncertainties and make recommendations. Results will be provided on an annual basis to CEPP Project Managers, agency leads and the general public as part of the SFER (South Florida Environmental Report). Conclusions and recommendations for adaptive management actions will be provided every 2-3 years after integration with monitoring results from RECOVER, CEPP (non-adaptive management), and other agencies (non-CEPP) such as USGS, EPA, FWS, etc. This integration, reported by RECOVER, will evaluate the triggers/thresholds that indicate good CEPP performance. For tree islands, this will require the creation of a new suite of RECOVER Tree Island Performance Measures. Examples include; 1) timing and amplitude of water depth fluctuations, 2) soil moisture, and 3) sediment accumulation rates.

The process to establish and recommend an adaptive management action will be more complicated than simply reporting because it will be constrained by: 1) limitations of the BACI approach, 2) the soil properties in the downstream testing environment, 3) the resilience of the downstream soil and vegetation (i.e., their inability to change), and 4) CEPP sequencing. RECOVER was designed to have the scientific and organization framework to manage this degree of complexity. With appropriate staffing, RECOVER will review the detailed strategies for each of the three adaptive management downstream study areas (i.e., NE-WCA-3A, Blue Shanty Flowway and central SRS), to include but not be limited to detailed methods, scientific focus, engineering practicality, field logistics and restoration relevance. Once an adaptive management study is implemented, and at least two years of post-construction data has been reviewed, RECOVER will evaluate results and may recommend staying with the methods or modifying them, or may suggest a new management action.

Management options that may be chosen to improve performance and assess the role of surface water depth and duration on soil organic content, moisture and bulk density for reducing soil oxidation and frequency of fire events: While effects of muck fire events are broadly accepted as negative, an improved understanding of these events in their local ecological context will increase the ability of managers to adopt appropriate strategies to efficiently and ecologically control them. Thus, feedback to CEPP management could include informing project decisions such as timing of delivering water, pulsing of delivery water, managing FEB/STA water to rise water tables to enhance or increase soil moisture in areas where surface water depth and duration has been lowered than originally specified. Suggested adaptive management options for regions of CEPP water control structures listed below are not in any particular order and can be implemented simultaneously, as appropriate. Options that may be considered for a future increment of CERP are suggested in the management options matrix.

- Increase operational flexibility to minimize frequency of muck fires in areas where organic soils experience extreme dry conditions.
- Incremental increases to WCA-3B hydroperiods increase soil moisture and diminish fire events to create more resilient environment in anticipation of a future increment of CERP.
- Adjust operations along the northern boundary of WCA-3A by redistributing water into the S8.

1.4.2.5 Everglades Predators: Alligators

CEPP Adaptive Management Uncertainty #10: **How much will CEPP improve alligator relative density and body condition in northern WCA 3A, WCA 3B and northeast Shark River Slough (NESRS)?** (Driver or Uncertainty type: hydro-ecological)

This uncertainty is related to the CEPP objectives of: 1) restoring more natural water level responses to rainfall to promote plant and animal diversity and habitat function and 2) reducing water loss out of the natural system to promote appropriate dry season recession rates for wildlife utilization. It relates to all regions and features of CEPP, but the greatest opportunities for learning are immediately downstream of major restoration features. These features include the HRF Spreader Canal in NW WCA-3A, the Blue Shanty Flowway in WCA-3B and the two Tamiami Trail bridges.

What is expected to be learned by addressing this uncertainty, i.e., how will CEPP benefit from addressing this uncertainty? Addressing this uncertainty provides information that will enhance the ability of CEPP to improve and restore a key ecological attribute of the Everglades. Alligators play a key ecological role in the Everglades by improving ecological diversity and function through creation of alligator holes, trails, and nests. However, in many areas such as northwestern Water Conservation Area 3, conditions are too dry to support alligator populations at targeted levels; thus, these other ecological benefits and functions are not occurring. The CEPP adaptive management monitoring plan will provide a way to determine more specifically the values of hydrological parameters (hydroperiod, depth, frequency of drydown) that are necessary to maintain healthy alligators and alligator populations at targeted levels. Resolving this uncertainty will contribute to our understanding of how much water is needed for a restored Everglades.

Expectations and hypotheses to be tested to address uncertainty, and attribute(s) that will be measured: Our hypothesis is that more natural hydrologic patterns with drydowns no more frequent than once every 3-5 years (creating multi-year hydroperiods) will improve both alligator body condition and relative density of alligators. This uncertainty will be evaluated in three separate regions of the Greater Everglades (NW WCA-3A, Blue Shanty Flowway and central SRS), but not at the same time. As a result, findings from the region that is restored first will impact adaptive management strategies to follow. The Alligator Production Suitability Index Model (Shinde et al. 2013) will be used to provide input for guiding strategies and determining expectations based on expected hydrologic improvements. Specific attributes and expectations include:

- Alligator Body Condition: Longer hydroperiods and less frequent drydowns will result in alligator body condition that is less variable from spring to fall and higher than pre-project.

- Alligator Relative Density: Longer hydroperiods and less frequent drydowns will result in an increase in relative density of alligators. Maximum relative densities will be achieved if drydowns are on average once every 3-5 years.

Methodology for testing each expectation or hypothesis: The testing of this hypothesis will be done in conjunction with the BACI (Before-After-Control-Impact) methodology used for uncertainties related to restoring hydrology for ridge and slough and tree island elevation everywhere in the Greater Everglades.

In this approach, the before period is defined by measurements made 2-3 years prior to the impact (e.g., operation of the Blue Shanty gated culverts) and the after as the period during and following feature completion. Control and impact reflect the regions not influenced and influenced by the structures and features, respectively. The monitoring will use a multidisciplinary approach that directly couples the monitoring of hydrology, and wildlife. For this hypothesis attribute-specific methodologies will include:

Alligator Body Condition: Fifteen alligators will be captured in spring and fall in areas downstream of features and in control areas following protocols developed for RECOVER MAP (Mazzotti et al. 2010). Alligators will be measured, weighed, marked, gender determined and released at their site of capture. Body condition will be calculated using the Fulton's K body condition index. EDEN data will be used to describe prior and current hydrologic variables including hydroperiod, average water depths at various time steps prior to capture and yearly water depth amplitude prior to capture.

Alligator Relative Density: Night-time spotlight counts will be conducted in spring and fall in areas downstream of features and in control areas along designated survey routes following protocols developed for RECOVER MAP (Mazzotti et al. 2010). Environmental data will be taken at the beginning and end of each survey and location and size estimate of all alligators observed will be recorded. A minimum of two transects conducted twice each season will be used. Hydrology data from key USGS gauges as well as data from EDEN will be used to describe both hydrologic conditions at the time of the surveys and hydrologic conditions (hydroperiod, depths, and amplitude) in the 1-5 years prior to the surveys.

How results will be reported, and the triggers/thresholds that indicate good CEPP performance or need for adaptive management action: Results will be reported in the context of what is expected given the improvements to hydrology (estimated using The Alligator Production Suitability Index Model (Shinde et al. 2013)) and in comparison to established targets (Mazzotti et al. 2009). Results will be provided on an annual basis to CEPP Project Managers, agency leads and the general public as part of the SFER (South Florida Environmental Report). Conclusions and recommendations for adaptive management actions will be provided every 2-3 years after integration with monitoring results from RECOVER, CEPP (non-adaptive management), and other agencies (non-CEPP) such as USGS, EPA, FWS, etc. This integration, reported by RECOVER, will evaluate the triggers/thresholds that indicate good CEPP performance (see Mazzotti et al. 2009).

Management options that may be chosen to improve performance and assess the role of hydroperiods and depths for improving alligator body condition and relative density: Feedback to CEPP management will include providing information that can inform project decisions such as timing of delivering water, or routing water through an area slightly differently than originally specified. Suggested adaptive management options listed below are not in any particular order and can be implemented simultaneously, as appropriate. Options that may be considered for a future increment of CERP are suggested in the management option matrix.

- Incremental increases in flows through WCA 3B to recreate historic slough paths.
- Adjust operations along the northern boundary of WCA 3A by redistributing water into the S8.

1.4.2.6 Prey Densities

CEPP Adaptive Management Uncertainty #9: **How much will hydrologic restoration and vegetation management result in increases in prey densities (aquatic fauna)?** (Driver or Uncertainty type: hydro-ecological)

This uncertainty is related to the CEPP objectives of: 1) restoring more natural water level responses to rainfall to promote plant and animal diversity and habitat function and 2) reducing water loss out of the natural system to promote appropriate dry season recession rates for wildlife utilization. It relates to all regions and features of CEPP, but the greatest opportunities for learning are immediately downstream of major restoration features. These features include the HRF Spreader Canal in NW WCA-3A, the Blue Shanty Flowway in WCA-3B and the two Tamiami Trail bridges.

What is expected to be learned by addressing this uncertainty, i.e., how will CEPP benefit from addressing this uncertainty? Addressing this uncertainty provides information that will enhance the ability of CEPP to improve and restore the availability of critical, food-web fish and invertebrates. Changes in the densities, availability and spatial distributions of aquatic prey are needed to restore historic food-web interactions, especially for wading birds. However, in many areas such as northwestern Water Conservation Area 3, WCA-3B and SRS, conditions are too dry or recession rates are too fast, to support prey populations at significant levels. The CEPP adaptive management plan will provide a way to determine more specifically the values of hydrological parameters (hydroperiod, depth, frequency of dry-down) that are necessary to restore and sustain a healthy prey-base throughout the Greater Everglades, but especially in regions that were once known for supporting wading bird supercolonies.

Expectations and hypotheses to be tested to address uncertainty, and attribute(s) that will be measured: Central to this uncertainty is the hypothesis that restoration of multi-year hydroperiods to northern WCA 3A, WCA 3B, and NESRS will result in increased density of aquatic fauna and large fish. More specifically, will infrequent drydowns (i.e., no more frequent than once every 5 years) significantly improve density of small and large fish, and will this translate into a more resilient and available food base for wading birds and other large predators? This uncertainty will be evaluated in three separate regions of the Greater Everglades (NW WCA-3A, Blue Shanty Flowway and central SRS), but not at the same time. As a result, findings from the region that is restored first will impact adaptive management strategies to follow. The Fish Habitat Suitability Index Model (Trexler et al. 2003) will be used to provide input for guiding strategies and determining expectations based on expected hydrologic improvements. Specific attributes and expectations include:

- Aquatic Prey: The density of small fish (8 cm or less standard length) and prey invertebrates such as, grass shrimp and crayfish will significantly increase downstream of the new water control structures, in NE WCA-3A where hydroperiods are expected to increase by 35%, and along the edges of SRS.
- Large Fish: The distribution, movement and density of large fish (>8 cm standard length) will expand and increase into areas with annual average hydroperiods in excess of 11 months.

Methodology for testing each expectation or hypothesis: The testing of this hypothesis will be done in conjunction with the BACI (Before-After-Control-Impact) methodology used for uncertainties related to restoring hydrology for ridge and slough and tree island elevation everywhere in the Greater Everglades. In this approach, the "before" period is defined by measurements made 2-3 years prior to the initiation of CEPP operations that will affect the area (e.g., operation of the Blue Shanty gated culverts) and the after as the period during and following feature completion. Control and impact reflect the regions not influenced and influenced by the structures and features, respectively. The monitoring will use a multidisciplinary approach that directly couples the monitoring of hydrology and aquatic fauna. Detailed methodology for assessment of fish performance is available in the DECOMP Performance Measure Documentation Sheet for Prey-Based Freshwater Fish Density. This monitoring will include presence/absence monitoring for invasive and nuisance fish species and will be coordinated with the INSMP team to consolidate monitoring trips and reduce costs**.** Attribute-specific methodologies will include:

- Aquatic Prey: Aquatic prey populations are monitored using one square meter throw traps. Throw trap samples will be collected in primary sampling units in areas that were identified as feasible for throw-trap sampling. Selection of primary sampling units will be based on a spatially balanced recursive tessellation design. Throw trap locations within a primary sampling unit are three fixed coordinates within a ten meter by ten meter cell drawn randomly from the habitat that can be sampled. Landscape estimates for standing crops of prey populations are interpolated via standard kriging across the sampling domain.
- Large Fish: Same as above for small fish plus wet season satellite tracking.

How results will be reported, and the triggers/thresholds that indicate good CEPP performance or need for adaptive management action: The BACI statistical design will be used to formulate conclusions, address the uncertainties and make recommendations. Results will be provided on an annual basis to CEPP Project Managers, agency leads and the general public as part of the SFER (South Florida Environmental Report). Conclusions and recommendations for adaptive management actions will be provided every 2-3 years after integration with monitoring results from RECOVER, CEPP (non-adaptive management), and other agencies (non-CEPP) such as USGS, EPA, FWS, etc. This integration, reported by RECOVER, will evaluate the triggers/thresholds that indicate good CEPP performance based upon established and approved RECOVER Performance Measures. Specifically, the distribution and density of small fish will trigger an adaptive management action if any of the following are true: if one year is at least three standard errors above or below the limits of an objective interval; if two out of three years are at least two standard errors above or below the limits of an objective interval; or if four out of five consecutive years are at least 1.5 standard errors above or below the limits of an objective interval.

Management options that may be chosen to improve performance and assess the role of extended hydroperiods and flow for the restoration of aquatic prey densities. Feedback to CEPP management will include providing information that can inform project decisions such as timing of delivering water, or routing water through an area slightly differently than originally specified. Suggested adaptive management options listed below are not in any particular order and can be implemented simultaneously, as appropriate.

- Concurrent or series testing of vegetation management options (e.g., fire, harvesting, herbicide, physical stress) downstream of the NW WCA 3A HRF and the 67A conveyance features to create preferential flow paths in historic flow path locations.
- Increase operational flexibility to maximize flow velocities in the Blue Shanty flowway including; 1) hydrological pulsing, 2) Implement rest of L-67A conveyance features for additional flow as described in the CEPP Plan, 3) vegetation management or clearing.
- Incremental increases in flows through WCA 3B to re-create slough paths.
- Adjust operations along the northern boundary of WCA 3A by redistributing water into the S8.

1.4.2.7 Wading Bird Foraging Conditions and Nesting

CEPP Adaptive Management Uncertainty #75: **How much will hydrologic restoration and vegetation management result in increases in wading bird foraging conditions and increased nest number and success of Wood Storks and Roseate Spoonbills?** (Driver or Uncertainty type: hydro-ecological)

This uncertainty is related to the CEPP objectives of: 1) restoring more natural water level responses to rainfall to promote plant and animal diversity and habitat function and 2) reducing water loss out of the natural system to promote appropriate dry season recession rates for wildlife utilization. It relates to all regions and features of CEPP, but the greatest opportunities for learning are immediately downstream of the HRF Spreader Canal in NW WCA-3A, in SRS downstream of the two Tamiami Trail bridges, and in Florida Bay downstream of Taylor Slough. By addressing this uncertainty in combination with the one above (Aquatic Prey Density), this CEPP adaptive management plan is expected to increase GE wading bird populations everywhere in the Everglades, but mostly in ENP.

What is expected to be learned by addressing this uncertainty, i.e., how will CEPP benefit from addressing this uncertainty? Addressing this uncertainty provides information that will enhance the ability of CEPP to restore critical, keystone populations of egrets, ibis, herons, storks, cranes and spoonbills in terms of their abundance, spatial distributions and reproductive viability. Wading birds are not utilizing the ENP for foraging or nesting as they did 100 years ago. The CEPP adaptive management monitoring plan will provide a way to determine more specifically the values of hydrological parameters (hydroperiod, depth, frequency of dry-down) and ecological parameters (prey density, vegetation, exotics) that are necessary to restore and sustain wading bird populations throughout the Greater Everglades, but especially in regions that were once known for supporting wading bird super colonies.

Expectations and hypotheses to be tested to address uncertainty, and attribute(s) that will be measured: Central to this uncertainty is the hypothesis that 1) restoration of more natural ridge and slough patterns coupled with appropriate recession rates will result in an increase in wading bird foraging conditions, 2) restoration of multi-year hydroperiods to northern WCA 3A, WCA 3B, and NE Shark River Slough will result in increased density of aquatic prey, earlier nesting and increased fledgling success, and 3) restoration of short hydroperiod wetlands will increase dry season prey availability, and promote earlier nest initiation (November/December) and nest success of Wood Storks and Roseate Spoonbills in the southern Everglades. This uncertainty will be evaluated in four separate regions of the Greater Everglades (Northern WCA-3A, WCA-3B, central SRS and Florida Bay). A Wading Bird Habitat Suitability Index (HSI) Model (Beerens et al. 2012), a Wood Stork HSI (LoGalbo, et al., 2012) and a Spoonbill HSI will be calibrated to provide input for guiding strategies and determining project performance expectations based on expected hydrologic improvements. Specific attributes and expectations include:

- Wading Birds: Increase in foraging conditions within short hydroperiod wetlands along flanks of SRS, and a shift in timing of nest initiation to November/December
- Wood Storks and Roseate Spoonbills: Increase in nesting success in southern Everglades due to earlier fledging dates and a decrease in nest abandonment and nest predation.
- All: Overall net gain in foraging conditions throughout the project area; 20% increase over baseline of foraging conditions in short hydroperiod wetlands.

Methodology for testing each expectation or hypothesis: The testing of these hypotheses will be done in conjunction with the BACI (Before-After-Control-Impact) methodology used for uncertainties related to restoring hydrology for ridge and slough, salinities in Florida Bay and prey densities in the regions of historic super colonies. In this approach, the before period is defined by measurements made 24 months prior to the impact (e.g., operation of the Blue Shanty gated culverts) and the after as the period during and following feature completion. Control and impact reflect the regions not influenced and influenced by the structures and features, respectively. The monitoring will use a multidisciplinary approach that directly couples the monitoring of hydrology, aquatic fauna, water quality, wading bird foraging and nesting success. Detailed methodology for assessment of Wading Bird performance (including Wood Storks and Spoonbills) is available in the RECOVER Performance Measure Documentation Sheets (GE-21 and GE-22) for Wetland Trophic Relations and Bancroft et al. (2002). Attribute-specific methodologies will include:

- Hydrology: Hydroperiods, stage and depths across the landscape before, during and after foraging will be calculated from USGS and SFWMD stage gauges and interpolated using USGS EDEN kriging techniques.
- Aquatic Prey: Use protocols developed for RECOVER MAP to measure dry season prey availability. Aquatic prey populations will be monitored using one square meter throw traps and will be collected before and after wading bird dry season foraging events downstream of CEPP structures and features.
- Wading Birds: Bird foraging counts, nest location, nesting success and fledgling success will be conducted using bi-weekly or monthly overflights of foraging and nesting locations as per Bancroft et al. (2002)

How results will be reported, and the triggers/thresholds that indicate good CEPP performance or need for adaptive management action: The BACI statistical design will be used to formulate conclusions, address the uncertainties and make recommendations. Results will be provided on an annual basis to CEPP Project Managers, agency leads and the general public as part of the SFER (South Florida Environmental Report). Conclusions and recommendations for adaptive management actions will be provided every 2-3 years after integration with monitoring results from RECOVER, CEPP (non-adaptive management), and other agencies (non-CEPP) such as USGS, EPA, FWS, etc. This integration, reported by RECOVER, will evaluate the triggers/thresholds that indicate good CEPP performance based upon established and approved RECOVER Performance Measures. Specifically, restoration targets for mainland nesting patterns as stipulated in the CERP Documentation Sheet GE-22 Wetland Trophic Relationships and based upon work by Ogden, Bancroft and Frederick (1997), Ogden (1994) and Gawlik et al. (2003). These include the following:

- CEPP is expected to increase wading bird nesting pair numbers in mainland colonies that move towards the minima of 4,000 pairs of Great Egrets, 10,000 to 20,000 combined pairs of Snowy Egrets and Tricolored Herons, 10,000 to 25,000 pairs of White Ibis, and 1,500 to 2,500/3,000 pairs of Wood Storks.
- Shift the timing of nesting in mainland colonies to more closely match preproject conditions. Specific recovery objectives would be for storks to initiate nesting no later than January in most years (as early as December in some years), and for ibis, egrets and herons to initiate nesting in February - March in most years (especially in ecotone colony locations).
- The return of major Wood Stork, Great Egret and ibis/small egrets and herons nesting colonies from the Everglades to the coastal areas and the headwaters ecotone of the mangrove estuary of Florida Bay and the Gulf of Mexico.
- The reestablishment of historical distribution patterns of Wood Stork nesting colonies in the region of mainland mangrove forests downstream from the Shark Slough and Taylor Slough basins. Increase the proportion of birds that nest in the southern ridge and slough marsh-mangrove ecotone (headwaters) to greater than 50% of the total for the entire Everglades basin.
- For storks, an annual reproductive productivity for all colonies combined of greater than 1.5 chicks per active nest
- An increase in the return, frequency, and size of wading bird super colonies consisting primarily of White Ibis in response to interannual variation in rainfall in the tributary headwaters of Shark

River Slough and other Gulf of Mexico mangrove estuaries at a frequency of 1 to 2 events per decade.

Management options that may be chosen to improve performance and assess the role of hydrology and ecology for wading bird restoration: Feedback to CEPP management will include providing information that can inform project decisions such as timing of delivering water, or routing water through an area slightly differently than originally specified. Adaptive management options would be considered if 3-year moving averages of nesting success were not showing an increase or if after 3 years there is not an overall gain in foraging conditions throughout the project. Suggested adaptive management options listed below are not in any particular order and can be implemented simultaneously, as appropriate. Options that may be considered for a future increment of CERP are suggested in the management options matrix.

- Concurrent or series testing of vegetation management options (e.g., fire, harvesting, herbicide, physical stress) downstream of the NW-WCA 3A HRF and the 67A conveyance features to create preferential flow paths.
- Increase operational flexibility to maximize flow velocities in the Blue Shanty flowway including; 1) hydrological pulsing, 2) Implement rest of L-67A conveyance features to test additional flow as described in the CEPP Plan, 3) Vegetation management or clearing.
- Incremental increases in flows through WCA 3B to recreate historic slough paths.
- Adjust operations along the northern boundary of WCA 3A by redistributing water into the S8.
-

1.4.2.8 WCA 3B Structures and Blue Shanty Flowway

CEPP Adaptive Management Uncertainty #77: Will full suite of CEPP TSP structures be required in WCA 3B to create the Blue Shanty Flowway? (Driver or type: Structural; informing CEPP implementation)

This CEPP Adaptive Management Uncertainty is related to all of the CEPP restoration objectives, and the constraint of maintaining level of service for flood protection and maintaining the resources of WCA 3B. The region is WCA 3B, LEC seepage management, NE SRS. The associated CEPP and non-CEPP features include the L-67A gated structures and associated L-67C gaps, S-333, S-355s, S-356, L-29.

What is expected to be learned by addressing this uncertainty, i.e., how will CEPP benefit from addressing this uncertainty? At times adaptive management plans can support conflict resolution by providing a plan to collect reliable data to answer outstanding questions. The strategy proposed here will inform discussions of:

1. whether three gated structures proposed in the TSP for the L-67A are needed to meet sheetflow, hydroperiod, flow directionality, and flow velocity goals;
2. the effects of additional flow in WCA 3B on the resources in WCA 3B, e.g., tree islands, sawgrass communities, biogeochemistry that shapes the system;
3. the direction of flow and extent of seepage when additional water enters WCA 3B through an L-67A gated structure to confirm or refute the need for the proposed Blue Shanty Levee to direct water south and under the Tamiami Trail Bridge toward Shark River Slough, and maintain level of service for LEC flood risk management.

If restoration objectives and constraints can be accomplished with fewer structures than proposed in the TSP then CEPP may experience cost savings and alleviate the need to construct additional features.

Expectations and hypotheses to be tested, and attributes that will be measured to test each.

A. **Hypothesis A -** Fewer than three gated structures in L-67A may provide sufficient flow through WCA 3B to meet *interim* hydrological targets set during CEPP's planning for this area (not full CERP restoration flow targets, as described in PIR **Section E.3.4 Evaluation Criteria for Storage and Treatment Options**), which will preserve and restore tree islands and promote restoration of ridge and slough habitat in WCA 3B. Attributes to monitor when one L-67A gated structure has been installed: water depths, flow direction, flow velocity, hydroperiods, tree island vegetation, ridge vegetation, and slough floc transport in WCA 3B. More detail about monitoring tree islands and ridge and sloughs is provided in the adaptive management strategies specific to these topics.
B. **Hypothesis B -** CEPP planning models showed flow and seepage moving eastward perpendicular to historic flow patterns and current landscape features when additional water was provided through the proposed L-67A gated structures, which supported the need for the Blue Shanty Levee in the TSP. This adaptive management strategy will investigate whether water may move south and under the Tamiami Trail Bridge rather than east to potentially alleviate the need for the Blue Shanty Levee. Note that removal of the Blue Shanty Levee from the TSP would require extensive engineering review and potential adjustments to the L-67C degrade in the TSP to maintain the integrity of the levee system. Attributes to monitor in addition to those listed above: pump operations related to managing WCA 3B seepage, water flow directionality from gated structures; water depth and flow volumes from WCA 3B to northeast Shark River Slough; and water depth east of the L-30 in Dade-Pennsuco Wetlands.

More Information on Attributes to be measured. For each attribute, specify the following.

- **What is expected to be learned by measuring this attribute, i.e., how will CEPP benefit from knowledge gained about this attribute?** See the Ridge and Slough CEPP adaptive management strategy for more information on several of these attributes, and others related to vegetation change.
  - Water depths – need to monitor water depths to ensure that they are not too deep for conservation of WCA 3B resources. WCA 3B has experienced peat and soil loss since the C&SF canal system was installed and therefore returning the area too quickly to pre-drainage water depths is not feasible. Interim hydrologic targets were determined during CEPP planning and can guide the expectations for this attribute and are described in described in CEPP PIR **Section E.3.4 Evaluation Criteria for Storage and Treatment Options.** In addition, the following targets were provided by the FWC and will be considered: If in any year, depths in WCA3B exceed 8.5' stage at site 7-1 for more than 59 days, monitoring of tree island health should be initiated. If significant stress to trees is detected measures should be taken when possible to achieve more favorable conditions during the following water year to reduce stress on tree islands in WCA3B. If average water levels at the 62 and 63 gauges increase above 11.6', actions should be taken when possible to reduce levels as soon as possible to avoid unintended effects on WCA 3B resources.:
  - Flow direction – Ideally most of the water added by CEPP to WCA 3B will flow south to Shark River Slough, which was the historic flow path in the recent centuries before drainage. Monitoring flow direction in WCA 3B will establish whether additional structures and operational refinements are needed to guide the water south. At the time of writing this adaptive management strategy it was suggested that flow directions moving 30 degrees east or more from historical flow patterns could impact restoration success; this estimate may be adjusted based on information gained from the Decomp Physical Model or other relevant sources.

- Flow velocity – Velocity of ~2.5 cm/sec for ~4 weeks per year should be sufficient, combined with supporting water depths and hydroperiods, to entrain sediments in the flow and thereby scour sloughs while building ridges. Monitoring flow velocity will indicate whether CEPP structures and operations are meeting the velocity requirement.
- Hydroperiods – The Everglades naturally vary between wetter and dryer times; monitoring WCA 3B hydroperiods will confirm that CEPP structures and operations provide the needed rotation of wetter and dryer times. Interim hydroperiod targets were set during CEPP planning and can guide the expectations for this attribute and are described in described in CEPP PIR **Section E.3.4 Evaluation Criteria for Storage and Treatment Options**. In addition, tree island ecologists have provided this guideline based on data collected in the Everglades:
  - <u>Multiple Years of Inundation</u>: It takes 3-5 years of sequential inundation of more than 120 days/yr for a WCA-3B tree island to lose more than 50% of its plant community.
- Pump operations related to managing WCA 3B seepage; and flow volumes from WCA 3B to northeast Shark River Slough – If the S-333 and S-356 pump stations sufficiently move water out of WCA 3B to prevent unintended water depths and head increases, and if the water can be routed to northeast Shark River Slough it may be feasible to complete the CEPP Blue Shanty flowway through the southern end of WCA 3B, as described in the TSP, without constructing the Blue Shanty Levee. There is a possibility that the S355s may also contribute to this effort although they are not operational at the time of writing this strategy. It is noted that there would be significant challenges associated with creating a flowway without the levee, such as the reduced ability to control hydroperiods and stages in the portion of WCA 3B that would otherwise be east of the new levee. The potential to overdrain the eastern side of WCA 3B, to have unintended effects on seepage into the LEC, or other inadvertent hydrological effects of creating a flowway without the levee would need to be thoroughly examined before making a decision to proceed.

- **What is the time frame in which changes to this attribute are expected to be measurable?**
  - Data will be needed for a minimum of 2-3 wet and dry seasons after first gated structure is installed for minimum statistical power for all of the attributes listed.
- **Is this attribute complimented by other monitoring programs (within and/or outside of CEPP)?** The data described here will compliment and be complimented by the CEPP adaptive management tree island and ridge and slough strategies, the CEPP Ecological Monitoring Plan, the CEPP Hydrometeorological Monitoring Plan, the RECOVER MAP, and Loxahatchee Impoundment Landscape Assessment (LILA) monitoring, and the Decomp Physical Model. It may also be complimented by agency monitoring such as Fish and Wildlife Commission, South Florida Water Management District, and Broward and Miami-Dade County monitoring programs.
- **When during CEPP's life cycle should this monitoring begin and end?** If baseline data cannot be determined from existing programs for the attributes listed, baseline monitoring should begin 2-3 years before the first gated structure is installed in the L-67A. After constructing the north L-67A structure and associated L-67C gap, the monitoring should continue until 2-3 wet and dry seasons of data have been collected to determine the results of the first gated structure. The results will inform decision makers about the need for additional structures. If structures are then constructed, it may be desired to continue the monitoring to make sure that restoration objectives are being met while constraint limits are avoided. The number of years of this

monitoring may be determined by how confident parties are in the effects of the additional structures, i.e., remaining uncertainty may be resolved with commensurate monitoring.

Methodology for testing each expectation or hypothesis. Methods are partially described in the CEPP adaptive management tree island and ridge and slough strategies; more detailed methods will be determined in coordination with CEPP PED and design phases.

How results will be reported, and the triggers/thresholds that indicate good CEPP performance or need for adaptive management action. The triggers/thresholds will be based on the input provided by CERP agencies and scientists, and the hydrologic targets developed during CEPP planning described in CEPP PIR **Section E.3.4 Evaluation Criteria for Storage and Treatment Options**, which do *not* call for full-restoration hydrological stages or hydroperiods due to the present ecological condition of WCA 3B.

Management options that may be chosen based on results. The options are not mutually exclusive. Additional options may be developed as knowledge is gained during CEPP design and during the testing.

- Implementation schedule for CEPP may be adjusted, if needed, to provide time for data collection after first L-67A gates structure is operational.
- If initial gated structure flows are acceptable then proceed with discussing with the PDT options for creating a flowway in southern WCA 3B without the Blue Shanty Levee. This may be accomplished by adding another gated structure in the L-67A, potentially gapping L-67C rather than removing a portion of it (to maintain levee system integrity), and using structures in L-29 to create the flowway while maintaining flood risk management. Note the potential issues described above that could be associated with not constructing the levee.
- Determine whether filling agricultural ditches in the flowway is needed to improve flow conveyance using S355, S333 structures to move water through Tamiami Trail Bridges. Filling the ditches may be considered a future increment of CERP.

Table D.1.6: Greater Everglades Management Options Matrix – Northern Water Conservation Area 3A

Uncertain-ty ID	Time until changes are measurable	Indicator or Attribute	Specific property to be Monitored	Decision Criteria: Confirmation of CEPP Performance or Trigger(s) for Management Action	Management Action Options
73, 5	3 years	• Weather • Hydrology	• Rainfall • Flow Direction and Volume • Flow Velocity • Hydroperiod	• Flow directionality improvement from current west to east flow back to north to south historic flow direction • Long-term average annual flow increase into northern Water Conservation Area 3 of 210,000 acre-ft • Hydroperiod targets based on CEPP planning targets and agency input • Pulsed velocities reaching 2.5 cm/second or greater downstream of HRF for 4 weeks or more total during average and wet rainfall years	• Adjust operations along the northern boundary of WCA 3A by redistributing water into the S8. **Potential considerations for future CERP and non-CERP restoration projects:** Gap half of the C-11 extension spoil mounds; leave remaining in place to compare slough restoration rates; Retrofit the S-336G to the L-6 Diversion to deliver more water to the HRF.
5, 73	3 -10 years	• Soil Oxidation • Peat Accretion • Fire Frequency	• Soil Moisture Content • Peat Accretion • Fire Mapping • Radiometric Dating • Soil Decomposition	• Statistically significant increase soil moisture content • Organic soil content increase • Sediment elevation increase in ridges and tree islands • Statistically significant decrease in fire frequency	
73,76	3-10 years	• Biogeochem-istry	• Water Quality • Soil Dynamics • Periphyton	• Nutrient accumulation rates no greater than baseline in sawgrass plain areas and sloughs • Nutrient concentration increases in ridges and/or tree islands compared to marsh • No statistically significant nutrient increase in periphyton biomass, nor decrease in periphyton diversity • Sediment floc mobilization in sloughs	• Adjust operations along the northern boundary of WCA-3A by redistributing water into the S8. • Improve A-1 and A-2 FEB operations to increase water quantity while decrease nutrients loads. • Concurrent or series testing of vegetation management options (e.g., fire, harvesting, herbicide, physical stress) downstream of the NW-WCA 3A HRF **Potential considerations for future CERP and non-CERP restoration projects:** Fill, plug, or gap ditches and agricultural canals; spoil mound removal and vegetation clearing; backfill Blue Shanty North-South canal; adjust operations along the northern boundary of WCA 3A by redistributing water into the S8 or into a new HRF east of the Miami Canal; retrofit the S-336G to the L-6 Diversion to deliver more water to the HRF.
73, 76	5-20 years	• Ridge and Slough and Tree Islands	• Vegetation Community Structure – Vegetation Mapping • Ridge and Slough Structure, Bimodality • Tree Island Formation	• No increase in area expansion and density of cattail • Vegetation transition in Northwest WCA from woody herbaceous vegetation to sawgrass on ridges and water lily in sloughs • Ridge and slough spatial patterning beginning to form landscape • Measurable differences in biomodality of ridges and sloughs between CEPP treated and control sites.	
9	3-5 years	• Aquatic fauna	• Crayfish and Small Fish Density • Large Fish Density	• Increased crayfish, small and large fish densities, following improved hydroperiods	
10	4-6 years	• Alligator	• Relative density • Body condition	• Decreased variability in alligator body condition • Increased relative density of alligators	
75	4-6 years	• Wading Birds	• Foraging conditions • Nesting timing, success, and area	• Increased foraging conditions (concentration of aquatic fauna [prey]) in central WCA 3A (20% increased area over baseline conditions) • Shift in timing of nesting to November/December • Decreased wood stork nesting in WCA 3A (move to SRS)	
73, 76, 77	3-5 years	• Terrestrial mammals	• Species Diversity • Deer Abundance	• No change in upland species diversity in Northeast WCA 3A • No change or increases in deer abundance in Northeast WCA 3A	• Adjust operations of HRF feature to improve stages in Northeast WCA 3A for upland species.

Table D.1.7: Greater Everglades Management Options Matrix – Water Conservation Area 3B and Blue Shanty Flow Way

Uncertainty ID	Time until changes are measurable	Indicator or Attribute	Specific property to be Monitored	Decision Criteria: Trigger(s) for Management Acton	Management Action Options

Uncertainty ID	Time until changes are measurable	Indicator or Attribute	Specific property to be Monitored	Decision Criteria: Trigger(s) for Management Acton	Management Action Options
5, 73, 77	3 years	• Weather • Hydrology	• Rainfall • Flow Direction and Volume • Flow Velocity • Hydroperiod	• Flow directionality improvement from current west to east flow back to north to south historic flow direction • Decrease by 160 days on average that water depth goes below ground primarily in Blue Shanty Flowway • Measured flow increase east of Blue Shanty Flowway without significant water depth increase in average and dry years • Pulsed velocities reaching 2.5 cm/second or greater downstream of L-67 structures for 4 weeks or more total during average and wet rainfall years	• Adjust CEPP implementation schedule to allow time to measure flow into WCA 3B as described in the text for #77, then consider options for increasing flow through WCA 3B: o implementation of additional L-67A conveyance structures described in the CEPP Plan o gapping L-67C instead of full removal o Consider need for Blue Shanty Levee • Concurrent or series testing of vegetation management options (e.g., fire, harvesting, herbicide, physical stress) downstream of the L-67A conveyance features to restore preferential flow paths • Increase operational flexibility to maximize flow velocities in the Blue Shanty flowway including; 1) hydrological pulsing, 2) implement rest of L-67A conveyance features to test additional flow as described in CEPP Plan, 3) vegetation management or clearing • Provide incremental increases in flows through WCA 3B to restore sloughs **Potential considerations for future CERP and non-CERP restoration projects:** Expansion of collector canal 0.4 miles to connect to existing agricultural ditch for improved conveyance using 355B structure; fill, plug, or gap ditches and agricultural canals; spoil mound removal and vegetation clearing; backfill Blue Shanty North-South canal.
5, 73, 77	3 -10 years	• Soil Oxidation • Peat Accretion • Fire Frequency	• Soil Moisture Content • Peat Accretion • Fire Mapping • Radiometric Dating • Soil Decomposition	• Statistically significant increase soil moisture content • Organic soil content increase and soil bulk density • Sediment elevation increase in ridges and tree islands • No peat fires west of Blue Shanty and 20% decrease in peat fire frequency east of blue shanty	• Increase operational flexibility to minimize frequency of muck fires in areas where organic soils experience extreme dry conditions. • Incremental increases to WCA-3B hydroperiods to increase soil moisture and diminish fire events to create more resilient environment and increase peat elevations.
73,76	3-10 years	• Biogeoche mistry	• Water Quality • Soil Dynamics • Periphyton	• Nutrient pore water accumulation rates no greater than baseline in sawgrass plain areas and sloughs • Nutrient concentration increases in ridges and/or tree islands compared to marsh • No statistically significant TP increase in periphyton biomass, nor decrease in periphyton diversity • Increased sediment floc mobilization in sloughs	• Adjust operations to minimize nutrient load from canals vs. marsh water entering WCA 3B
73, 76	5-20 years	• Ridge and Slough and Tree Islands	• Vegetation Community Structure – Vegetation Mapping • Ridge and Slough Structure, Bimodality • Tree Island Formation	• No increase in area expansion and density of cattail • Sawgrass meadows will transition to sawgrass ridges and water lily sloughs, while maintaining tree islands • Measurable differences in bi-modality of ridges and sloughs between CEPP treated and control sites. • Tree island species diversity will be maintained	• Create moat-like sloughs around tree islands using vegetation management options (e.g., fire, harvesting, herbicide, physical stress). • Increase operational flexibility to maximize flow velocities in the Blue Shanty flowway including; 1) hydrological pulsing, 2) implement rest of L-67A conveyance features to test additional flow as described in CEPP Plan, 3) vegetation management or clearing

Uncertainty ID	Time until changes are measurable	Indicator or Attribute	Specific property to be Monitored	Decision Criteria: Trigger(s) for Management Acton	Management Action Options
				• Increased in woody vegetation seedling recruitment on tree island heads • Increased density of herbaceous species, in lower elevation tree island tails	• Incremental increases to WCA 3B hydroperiods to increase elevations and create more resilient tree islands west and east of the Blue Shanty Levee
9	3-5 years	• Aquatic fauna	• Crayfish and Small Fish Density • Large Fish Density	• Increased crayfish, small and large fish densities, following improved hydroperiods	• Incremental increases in flows through WCA-3B to restore sloughs. • Concurrent or series testing of vegetation management options (e.g., fire, harvesting, herbicide, physical stress) downstream L- 67A conveyance features to restore preferential flow paths. • Increase operational flexibility to maximize flow velocities in the Blue Shanty flowway including; 1) hydrological pulsing, 2) implement rest of L-67A conveyance features to test additional flow as described in CEPP Plan, 3) vegetation management or clearing •
10	4-6 years	• Alligator	• Relative density • Body condition	• Decreased variability in alligator body condition • Increased relative density of alligators	

Table D.1.8: Greater Everglades Management Options Matrix – Shark River Slough

Uncertainty ID	Time until changes are measurable	Indicator or Attribute	Specific property to be Monitored	Decision Criteria: Trigger(s) for Management Acton	Management Action Options
73, 5	3 years	• Weather • Hydrology	• Rainfall • Flow Direction and Volume • Flow Velocity • Hydroperiod	• Decrease by 210 days on average that water depth goes below ground primarily in Northeast Shark River Slough • Measured flow increase reaching 2.5 cm/second or greater south of Tamiami Trail Bridge structures into Shark River Slough for 4 weeks or more total during average and wet rainfall years	• Increase operational flexibility to maximize flow velocities South of Tamiami Trail structures in combination with South-Dade Conveyance operations and seepage management features: o L-67 A conveyance through flow way into Shark River Slough o S-333 conveyance o S-355 and S356 structure operations • Remove L67 extension levee and old Tamiami Trail in phases: o beginning with 1.5miles of L-67 extension levee, associated canal, and adjacent section of old Tamiami trail o Remove most or all of L-67 extension levee and do not fill canal o Remove rest of L-67 extension levee and backfill canal
5, 73	3 -10 years	• Soil Oxidation • Peat Accretion • Fire Frequency	• Soil Moisture Content • Peat Accretion • Fire Mapping • Radiometric Dating • Soil Decomposition	• Statistically significant increase soil moisture content • Organic soil content increase and soil bulk density • Sediment elevation increase in ridges and tree islands • Fire frequency will not change in Rocky Glades, while peat fire frequency in northeast Shark River Slough will decrease by 20%	
73,76	3-10 years	• Biogeochemistry	• Water Quality • Soil Dynamics • Periphyton	• Nutrient pore water accumulation rates no greater than baseline in sawgrass plain areas and sloughs • Nutrient concentration increases in ridges and/or tree islands compared to marsh • No statistically significant TP increase in periphyton biomass, nor decrease in periphyton diversity • Increased sediment floc mobilization in sloughs	
73, 76	5-20 years	• Ridge and Slough and Tree Islands	• Vegetation Community Structure – Vegetation Mapping • Ridge and Slough Structure, Bimodality • Tree Island Formation	• No increase in area expansion and density of cattail • Measurable differences in bi-modality of ridges and sloughs between CEPP treated and control sites. • Expansion of ridge and slough along edges of shark river slough • Tree island species diversity will be maintained • Trend of tree island loss will decrease from 10% per decade on average to 0% • Increased in woody vegetation seedling recruitment on tree island heads • Increased density of herbaceous species, in lower elevation tree island tails	
9	3-5 years	• Aquatic fauna	• Crayfish and Small Fish Density • Large Fish Density	• Increased crayfish, small and large fish densities, following improved hydroperiods	
10	4-6 years	• Alligator	• Relative density • Body condition	• Decreased variability in alligator body condition • Increased relative density of alligators	
75	4-6 years	• Wading Birds	• Foraging conditions • Nesting timing, success, and area	• Increase in foraging condition area within short hydroperiod wetlands along flanks of SRS • Shift in timing of nest initiation to November/December	

Uncertainty ID	Time until changes are measurable	Indicator or Attribute	Specific property to be Monitored	Decision Criteria: Trigger(s) for Management Acton	Management Action Options
				• Increased Wood Storks and Roseate Spoonbills nesting success in southern Everglades due to earlier fledging dates and decreased nest abandonment and predation. • 20% increase over baseline of foraging conditions in short hydroperiod wetlands.	

1.4.3 Southern Coastal Systems Strategies and Management Options

Historically, freshwater flowed as sheetflow south from Lake Okeechobee, through the Everglades to the southern estuaries (e.g. Florida Bay, Lower Southwest Coast, and Biscayne Bay). Water management activities such as construction of canals to serve as surface water conveyance and flood control and protection as well conversion of historic wetlands to agriculture or urban land uses over the past several decades have altered the magnitude, distribution, and timing of the historic sheetflow conditions throughout the Everglades landscape (Ogden, 2005). The changes to surface water in combination with changes in ground water volumes has altered the timing and distribution through the southern sloughs (Taylor and Shark River) which lead to estuaries located along the south Florida coastline (i.e. Lower Southwest Coast to Biscayne Bay; Figure##). This change in timing and distribution has resulted in a shift from the historic mesohaline conditions to hypersaline conditions in several near shore estuarine areas. As a result of changing salinity conditions coastal wetlands and the "White" zone have shifted landward as the interface of the fresh and saline conditions has retracted. The transitional areas of the southern coastal wetlands of Florida Bay, the Lower Southwest Coast, and Biscayne Bay and the estuaries themselves, constitute some of the most ecologically productive areas in Florida, supporting a portion of Florida's tourism and fishing industry as well as being considered aesthetically amongst the most beautiful areas in Florida. The CEPP-specific questions below focus on the effects of additional fresh water and changes to the timing and distribution from CEPP to the coastal wetland and estuarine plant and animal species that represent the health of the southern end of the Everglades system.

As noted above, adaptive management will be reiterated in the coming phases of CEPP, and the Adaptive Management Plan will be revisited. At such time, more baseline data and lessons learned will be available from other monitoring programs and restoration projects. Given the new knowledge, key questions and adaptive management options proposed in this Plan may need refinement. Therefore, items included in this plan are not guaranteed to be included or funded as-is, but will be considered again when CEPP is closer to being implemented.

1.4.3.1 Avoiding Legacy Nutrients in Everglades Soils

The availability of legacy nutrients in Everglades soils, their subsequent movement through the system, and the ecological effects is dependent on a better understanding where the potential sources of nutrients are spatially distributed and their biogeochemical availability. Studies are needed prior to the completion of construction and operation of CEPP features to: 1) determine the location of legacy sources of nutrients that could be directly affected by CEPP water deliveries. Specific areas of concern include: downstream of S-12D and S-333, the L-67A and L-67C Canals, the Blue Shanty flow-way, Taylor Slough bridge, ENP lakes, and select coastal creeks into Florida Bay and the Lower Southwest coast; 2) understand the biogeochemical processes in ENP that affect the release of nutrients from the soils, and; 3) concentrations of mobilized nutrients and their downstream movement.

CEPP Uncertainty #63: Will there be downstream biogeochemical effects due to existing (legacy) conditions associated with modifying inflows and hydrologic conditions in ENP, including effects on nutrient movement, availability, and ecological responses? This includes consideration of hydrologic effects on nutrient loading, nutrient release from soils, transport, and water-quality related ecological indicators, such as periphyton tissue nutrients, cattail expansion, and algal bloom events, especially in eastern Florida Bay where nitrogen levels are relatively high?

CEPP Uncertainty #63 is focused on the effects of increased water volumes delivered past Tamiami Trail to Shark River and Taylor Sloughs on the mobilization, cycling, and transport of imported nutrients in the water column and suspension of legacy nutrients in the soils to the downstream areas of Florida Bay and the Lower Southwest Coast. The primary driver for this uncertainty is hydrology and nutrients.

The associated CEPP features are:

1. The S-12 Structures, S-333, S-335, S-334, the C-67 A and L-67C canals, L-29 Divide Structure, S-356, G-211; and
2. Blue Shanty Flow Way
3. The partial seepage barrier south of Tamiami Trail along L-31N.

The implementation of the CEPP as well as other projects and operational schemes may alter the flow and locations at which these flows enter SRS. These changes may have an impact on SRS compliance with the requirements of state law and Appendix A from the 1991 Settlement Agreement. For CEPP, the three most important aspects of Appendix A compliance assessment are as follows: (1) CEPP-related increases in flow may reduce the Long Term Limit (LTL) for TP; (2) the effect of the project implementation sequence on interim TP loads and concentrations; and (3) alteration of existing SRS inflow points and the addition of new inflow points. All of these may have some effect on Appendix compliance or the sufficiency of the compliance methodology and are currently undergoing review by a subteam assigned by the Everglades Technical Oversight Committee. Assuming the water delivered by CEPP past Tamiami Trail into the Park meets the Consent Decree water quality criteria, the increased water deliveries may result in the following due to existing (legacy) conditions: 1) the mobilization and redistribution of soil and plant tissue nutrients downstream, 2) an accelerated rate of cattail distribution expansion, and 3) an increase in the frequency, spatial extent, duration, and/or magnitude of algal blooms in Florida Bay and the Lower Southwest coast.

Nutrient Changes in Periphyton and Soil Nutrients: A baseline monitoring period of 6 years for soil nutrient content (1 every 2 years, 3 sampling events total) to measure long-term nutrient trends and 3 years of quarterly periphyton tissue nutrients in areas of concern (e.g. downstream of S-12D and S-333, the Blue Shanty flow way, Taylor Slough bridge) to measure early indication of nutrient changes is recommended to adequately establish existing conditions. Monitoring of soil nutrient content every 2 years and quarterly periphyton tissue nutrients beginning with construction of the first feature and/or operational change and carried through O/M is necessary to document any changes in nutrient distribution resulting from incremental increases in deliveries past Tamiami Trail with each constructed feature.

Cattail Expansion – Cattails are an indicator of persistent nutrient issues in the Everglades and the current rate of cattail expansion south of Tamiami Trail is not known. Analyses of historic databases and/or aerial photos may be necessary to determine the current rate of cattail expansion, setting the baseline condition for CEPP. Annual vegetation transects and landscape scale aerial vegetation mapping every 5 years in areas of concern (e.g. downstream of S-12D, the Blue Shanty flow way, Taylor Slough bridge) beginning with construction of the first feature and/or operational change and carried through O/M is necessary to document any changes to the vegetation distribution resulting from incremental increase in deliveries past Tamiami Trail with each constructed feature. The CEPP Invasive and Nuisance Species Management Plan (INSMP) acknowledges that cattail expansion may occur in the footprint of CEPP but does not investigate whether such expansion, should it happen, results from legacy nutrients in the ecosystem. If cattails expand, they may indicate a mobilization of legacy nutrients in the ecosystem and would trigger a potential need to change the timing and distribution of

CEPP's water in this area as described in the SCS management options below. In addition, the information will help the project team determine whether to dedicate resources to controlling the spread of the cattail, which would include consideration of whether project benefits are being impacted.

Coastal Creek Nutrient Loading Rates - Nutrient loading rates through coastal creeks into Florida Bay are well documented. Additional nutrient information is needed at existing Lower Southwest coastal creek flow monitoring stations to complete calculations of nutrient loading rates. A baseline monitoring period of 3 years of monthly monitoring of various water quality parameters (e.g. chlorophyll a, TP, TN) in Florida Bay, the Lower Southwest coastal estuaries and creeks is recommended to adequately establish existing conditions. To track post construction impacts on Florida Bay and Southwest coastal estuaries and creeks, as part of this adaptive management strategy monthly monitoring of various water quality parameters (e.g. chlorophyll a, TP, TN) should begin during early CEPP construction and/or operational change and continue for up to 10 years.

Water quality, soil nutrients, and ecological attributes have been selected to measure the effects of CEPP hydrologic modifications to the volume of freshwater delivery south of Tamiami Trail on the biogeochemistry of Shark River and Taylor Slough and the fate (both spatially and ecologically) of the nutrients that may be released from the soil legacy nutrient pool. The potentially affected region is bounded by Tamiami Trail to the north, L-31N and the C-111 canals to the east, and extends into the estuarine areas of Florida Bay and the Lower Southwest Coast. These attributes were selected based on existing knowledge of 1) surface/groundwater connectivity in Shark River and Taylor Sloughs and adjacent estuaries; 2) biogeochemical processes in Shark River and Taylor Sloughs; 3)potential to transport of nutrients and other materials through the region; and 4) known algal bloom dynamics in Florida Bay and the Lower Southwest Coast. Many of the attributes listed are currently monitored by other agencies or USACE projects and may provide, in part, input to the testing of this uncertainty's hypothesis. It is anticipated additional monitoring will be necessary for the Project, to be determined during Design. Costs for the additional monitoring have been included in the Monitoring Cost Table. The timeframe in which the attributes listed below will be able to measure changes as function of the Project range from a minimum of 2 months (periphyton and estuarine surface water quality) to a maximum of 5 years (soil nutrients). Estimated timeframes are listed below in parentheses.

The attributes to be measured are:

1. Periphyton (2 months)
2. Estuarine Surface Water Quality (2 months)
3. Cattail (2 years)
4. Soil Nutrients (5 years)

The full restoration target for each attribute listed above can be found in the following CERP Performance Measures:

1. RECOVER PM Greater Everglades Wetlands TP Concentrations in Surface Water
2. RECOVER PM Greater Everglades Wetlands Nutrient TN Concentrations in Surface Water
3. RECOVER PM Total Phosphorus Concentrations in Soil
4. RECOVER PM Wetland Trophic Relationships – Periphyton
5. RECOVER PM Southern Coastal Systems Water Quality

The CEPP restoration target for each attribute is listed below. These targets are based on the best professional judgment of scientists familiar with the region. Data analyses of existing conditions as referenced below may be found in the CERP RECOVER System Status Reports. Additional data analyses may need to be performed prior to any CEPP construction or operational change to determine existing conditions from pre-construction collected monitoring information.

- Increased flow will not alter current periphyton system-wide indicator report status
- Additional flows will not result in an increase in algal bloom events (frequency, spatial extent, duration, and/or magnitude) in Florida Bay and Lower Southwest coast relative to current conditions
- No acceleration in cattail distribution expansion rate relative to current conditions
- No alteration of current spatial distribution of soil and vegetation nutrient pools relative current conditions

The thresholds for the implementation of adaptive management measures for the region are listed below and constitute working hypotheses to be tested under the CEPP AM plan. Exceedence of any of the listed thresholds indicates need to consider the adaptive management measures suggested next. These threshold limits are based on the best professional judgment of scientists familiar with the region. Data analyses of existing conditions as referenced below may be found in the CERP RECOVER System Status Reports. Additional data analyses may need to be performed prior to CEPP construction or operational changes to determine existing conditions from pre-construction collected monitoring information.

- Increased frequency of yellow and/or red conditions for the periphyton nutrient content or algal bloom system-wide indicator report
- Increased rate of cattail expansion above current rate
- Movement of spatial nutrient front or increase in nutrient rate of release from soils as observed along soil and/or vegetation transect from existing conditions.

Suggested Adaptive Management Options listed below are not in any particular order and can be implemented simultaneously, as appropriate.

1. Spatial redistribution of water into less sensitive areas
2. Reduce point source discharges (e.g., S12A, S12B, S12C, S12D) and shift more water to the Blue-Shanty flowway
3. Redistribution of water to more closely match historic timing of flows to the coastal wetlands and estuaries
4. Refinement of existing hydrologic and hydrodynamic models in the southern coastal wetlands, Florida Bay, and the Lower Southwest Coast to increase ability to forecast effects of water management decisions
5. Cattail management/removal

1.4.3.2 Freshwater Flow and Florida Bay Salinity

CEPP Uncertainty #61
Will increased flows to northeastern Shark River Slough yield natural distribution of waters toward the southeastern Everglades (Taylor Slough and lower C-111 basin) and northeast Florida Bay without operation of the SFWMD Canal System east of the L30, L31-N, and L31-W?

CEPP Uncertainty #67
Will CEPP improve flows to Florida Bay and the Lower Southwest coast resulting in more natural salinity patterns (magnitude, spatial distribution and timing)? Will results be consistent with the expectations from the CEPP scenario model predictions?

CEPP Objective or Constraint:
Uncertainty #61 and 67 are related to the following CEPP objectives:

- Restore seasonal hydroperiods and freshwater distribution to support a natural mosaic of wetland and upland habitat in the Everglades System;
- Improve sheetflow patterns and surface water depths and durations in the Everglades system in order to reduce soil subsidence, the frequency of damaging peat fires, the decline of tree islands, and salt water intrusion;
- Reduce water loss out of the natural system to promote appropriate dry season recession rates for wildlife utilization; and
- Restore more natural water level responses to rainfall to promote plant and animal diversity and habitat function

Region(s).
CEPP Uncertainties #61 and 67 are focused on the connection between flows to Florida Bay improving salinities and the flexibility of CEPP and SFWMD Canal System water management operations to deliver waters to the region below Tamiami Trail (Shark and Taylor Sloughs, Florida Bay, and the Lower Southwest Coast) in a spatially and temporally balanced manner for the greatest amount of overall ecological restoration.

- **Associated CEPP features:** The L-30, L-31N, L-31W, C-111, Lower East Coast Service Area (LECSA) 2 & 3 SFWMD Canal System;
- The S-12 Structures, S-356, G-211, divide and coastal water management structures of the LECSA 2 & 3 SFWMD Canal System
- Blue Shanty Flow Way; and
- The partial seepage barrier south of Tamiami Trail along L-31N.

Driver or uncertainty type. The primary driver for this uncertainty is hydrology.

What is expected to be learned by addressing this uncertainty, i.e., how will CEPP benefit from addressing this uncertainty? Constructed features of CEPP are designed to yield a more natural distribution of water towards the southeastern Everglades and northeast Florida Bay. The CEPP operational plan focuses primarily on operational changes to the S-356 pump station and G-211 structure to actively move water to the west of the L-31N to compensate for seepage concerns along the L-31N and requires the integration of operations of the LECSA 2 & 3 SFWMD Canal System to achieve the predicted salinity regimes in at the Little Madeira Bay, Joe Bay, Trout Cove, Long Sound, Little Blackwater Sound, and

Barnes Sound Marine Monitoring Network stations. Operations of the LECSA 2 & 3 SFWMD Canal System can affect the flows in Taylor Slough and the lower C-111 basin and subsequently, salinities in Little Madeira Bay, Joe Bay, Trout Cove, Long Sound, Little Blackwater Sound, and Barnes Sound Marine Monitoring Network stations.

CEPP water deliveries south of Tamiami Trail are predicted to improve flows to Florida Bay and the Lower Southwest coast resulting in a more natural salinity pattern (magnitude, spatial distribution and timing). CEPP and LECSA 2 & 3 SFWMD Canal System operations and constructed features will result in: 1) a more natural flow distribution, 2) a more natural timing regime and 3) a greater magnitude of flows to Florida Bay and the lower Southwest coast.

Expectations or hypotheses to be tested to address uncertainty #, and attribute(s) that will be measured to test each.

More Information on attributes to be measured:

- ***What is expected to be learned by measuring this attribute, i.e., how will CEPP benefit from knowledge gained about this attribute?***
- ***What is the time frame in which changes to this attribute are expected to be measurable?***
- ***Is this attribute complimented by other monitoring programs (within and/or outside of CEPP)? If so, provide reference to other monitoring and make sure that monitoring paid for by others is noted in the CEPP adaptive management budget spreadsheet.***
- ***When during CEPP's life cycle should this monitoring begin and end?***

Hydrologic and water quality attributes are selected to measure the effects of CEPP operational modifications to the quantity, timing, and distribution of freshwater delivery in the region south of Tamiami Trail (Shark River and Taylor Sloughs, Florida Bay, and the Lower Southwest Coast). These attributes were selected based on existing knowledge of the surface/groundwater connectivity in Shark River and Taylor Sloughs and adjacent estuaries. Many of the attributes listed are currently monitored by other agencies or USACE projects and may provide, in part, input to the testing of this uncertainty's hypothesis. It is anticipated additional monitoring will be necessary for the Project, to be determined during Design. Costs for the additional monitoring have been included in the Monitoring Cost Table. The timeframe in which the attributes listed below will be able to measure changes as function of the Project range from a minimum of 7 days (wetland and canal/creek stage, surface and groundwater flow) to a maximum of 2 years (estuarine salinity). Estimated timeframes are listed below in parentheses.

The attributes to be measured, along with the timeframe in which changes are expected to be measureable in parentheses, are:

1. Estuarine Salinity (2 years)
2. Wetland and Canal/Creek Stage (7 days)
3. Surface and Groundwater Flow (7 days)

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting:

The expectation (hypothesis) is that CEPP will improve salinity ranges in Florida Bay, as evidenced by project alternative plan modeling. Real-time analyses of operational changes to the S-12 structures, S-333, and the LECSA 2 & 3 SFWMD Canal System and their subsequent affect on surface and ground water flows to the southern coastal creeks and salinity in Florida Bay and the Lower Southwest Coast prior to construction, during construction, and into O/M for CEPP should be pursued to provide feedback to water managers on operational decisions and their subsequent effect on the estuaries. Focus of the analyses are on the distribution, magnitude, and timing of surface and groundwater flows at water management structures, select wetland stage/flow gages, select coastal creek flow gages, and salinity at the Marine Monitoring Network stations. Preferably, refinement of the existing hydrologic and hydrodynamic models in the southern coastal wetlands, Florida Bay, and the Lower Southwest coast is necessary to better forecast the effects of operational changes prior to actual implementation and avoid irreversible negative impacts through a trial and error approach. This refined modeling analysis will help identify specific quantifiable hypotheses (CEPP performance expectations) to be confirmed with CEPP implementation

Triggers/thresholds that indicate good CEPP performance or need for adaptive management action. The restoration target triggers and baseline threshold for the implementation of adaptive management measures for the region are listed below. Non-attainment of any one of the restoration targets and/or exceedence of any one of the baseline thresholds necessitates the implementation of the adaptive management measures. These triggers and threshold are based on the best professional judgment of scientists familiar with the region, actual environmental monitoring data, modeled scenario data, and scientific research. Refinements or additions to the listed triggers and thresholds may occur in the future as new research and data are analyzed and incorporated by the PDT. Data analyses of existing conditions as referenced below may be found in the CERP RECOVER System Status Reports. Additional data analyses may need to be performed prior to any CEPP construction or operational change to determine existing conditions from pre-construction collected monitoring information.

CEPP Restoration Target Triggers:

- RECOVER Southern Coastal Systems Performance Measure: Salinity in Florida Bay (http://www.evergladesplan.org/pm/recover/recover_docs/perf_measures/062812_rec_pm_scs_salinity_flbay.pdf) metrics less than those predicted for the selected alternative (4R2) or exhibits a negative long-term trend at each of the 17 NPS Marine Monitoring Network stations in Florida Bay
- Stage/flow distribution inconsistent to those predicted for the selected alternative (4R2)

Baseline Thresholds:

- Salinity exceeds the 90th percentile of the recorded salinity values at the NPS Marine Monitoring Network in NE Florida Bay zone and near shore Florida Bay stations for the entire period of record for the equivalent rainfall years
- Violation of the Minimum Flows and Levels for Florida Bay

Management options that may be chosen based on test results. *Management Options are provided in case a performance trigger or threshold is crossed, which would indicate that CEPP performance needs to be adjusted. The Management Options are suggested paths forward and adjustments that can be made to keep CEPP progressing toward objectives and within constraints. The Management Options are summarized in 11x17 pull-out tables after each region's strategies.*

Suggested Adaptive Management Options listed below are not in any particular order and can be implemented simultaneously, as appropriate.

1. Adjustments to operations along Tamiami Trail and the LECSA 2 & 3 SFWMD Canal System to improve water deliveries to Florida Bay and the Lower Southwest Coast
2. Refinement of existing hydrologic and hydrodynamic models in the southern coastal wetlands, Florida Bay, and the Lower Southwest Coast

1.4.3.3 Sea Level Rise

CEPP Uncertainty #64
Will predicted CEPP flows mitigate saltwater intrusion and associated coastal wetland vegetation, soil stability, and nutrient retention or release?

CEPP Objective or Constraint:

Uncertainty #64 is related to the following CEPP objectives:

- Restore seasonal hydroperiods and freshwater distribution to support a natural mosaic of wetland and upland habitat in the Everglades System;
- Improve sheetflow patterns and surface water depths and durations in the Everglades system in order to reduce soil subsidence, the frequency of damaging peat fires, the decline of tree islands, and salt water intrusion;
- Reduce water loss out of the natural system to promote appropriate dry season recession rates for wildlife utilization; and
- Restore more natural water level responses to rainfall to promote plant and animal diversity and habitat function

Region(s).

CEPP Uncertainty #64 is focused on the biogeochemical effects of sea level rise (SLR)/saltwater intrusion into the southern coastal wetlands (lower portions of Shark River and Taylor Sloughs) adjacent to Florida Bay and the Lower Southwest Coast, its potential mitigation by increased flows across Tamiami Trail, and its impact on soil stability and nutrient release to the estuaries. Unmitigated SLR has the potential to impact Shark River and Taylor Sloughs miles inland of the current southern coastline.

Associated CEPP features: The associated CEPP features are:

1. The L-30, L-31N, C-111, LECSA 2 & 3 SFWMD Canal System canals;
2. The S-12 Structures, S-356, G-211, divide and coastal water management structures of LECSA 2 & 3 SFWMD Canal System
3. Blue Shanty Flow Way; and
4. The partial seepage barrier south of Tamiami Trail along L-31N.

Driver or uncertainty type: The primary driver for this uncertainty is hydrology.

What is expected to be learned by addressing this uncertainty, i.e., how will CEPP benefit from addressing this uncertainty? Sea level rise and saltwater intrusion is of great concern in the southern coastal wetlands as it has the potential to negatively impact restoration success. Increased salinities in the southern coastal wetlands and their subsequent effect on the coastal vegetation community have been documented. Increased salinities in the coastal wetlands have the potential to negatively impact the soil elevation, amplifying the effects of sea level rise. Flows delivered by CEPP to the southern coastal wetlands: 1) are sufficient to maintain or reverse the current spatial extent of surficial saltwater intrusion and associated mangrove and “white zone” expansion; 2) will influence plant growth and soil decomposition processes to increase rates of soil accretion, elevation increase, and minimize nutrient and material releases caused by peat collapse, mitigating the effects of sea level rise and; 3) will minimize the inland extent of the groundwater salt wedge resulting in a decreased rate of internal phosphorus release to surface water and subsequent transport to the estuaries decreasing the probability of an algal bloom event , especially on eastern Fl Bay where nitrogen levels are relatively high.

Expectations or hypotheses to be tested to address uncertainty #, and attribute(s) that will be measured to test each.

More Information on attributes to be measured:

- ***What is expected to be learned by measuring this attribute, i.e., how will CEPP benefit from knowledge gained about this attribute?***
- ***What is the time frame in which changes to this attribute are expected to be measurable?***
- ***Is this attribute complimented by other monitoring programs (within and/or outside of CEPP)? If so, provide reference to other monitoring and make sure that monitoring paid for by others is noted in the CEPP adaptive management budget spreadsheet.***
- ***When during CEPP's life cycle should this monitoring begin and end?***

Water quality, soil nutrients, and ecological attributes are selected to better understand the effects of CEPP hydrologic modifications to the volume of freshwater delivery south of Tamiami Trail and saltwater intrusion on the biogeochemistry, coastal wetland vegetation dynamics, and soil accretion within the southern coastal wetlands adjacent to Florida Bay and the Lower Southwest Coast. The area of concern is the southern coastal wetlands (lower portions of Shark River and Taylor Sloughs) adjacent to Florida Bay and the Lower Southwest Coast. These attributes were selected based on existing knowledge of 1) surface/groundwater connectivity in Shark River and Taylor Sloughs and adjacent estuaries; 2) biogeochemical processes in Shark River and Taylor Sloughs; and 3) soil accretion dynamics and mechanisms. Many of the attributes listed are currently monitored by other agencies or USACE projects and may provide, in part, input to the testing of this uncertainty's hypothesis. It is anticipated additional monitoring will be necessary for the Project, to be determined during Design. Costs for the additional monitoring have been included in the Monitoring Cost Table. The timeframe in which the attributes listed below will be able to measure changes as function of the Project range from a minimum of 1 year (wetland surface and groundwater quality) to a maximum of 5 years (soil nutrients, mangrove and white zone, soil elevation). Estimated timeframes are listed below in parentheses.

The attributes to be measured, along with the timeframe in which changes are expected to be measureable in parentheses, are:

1. Soil Nutrients (5 years)
2. Mangrove and White Zone (5 years)
3. Soil Elevation (5 years)
4. Wetland Surface and Groundwater Salinity (1 year)

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting:
More information on what to measure, how, how often, how to analyze, and when and how to report results. PLEASE NOTE: the CEPP adaptive management Plan varies in the level of methodology detail provided; in several cases the details will be formed after CEPP design details are known. In ALL cases, methodology will be reviewed, updated and adjusted if needed, by agency subject experts before initiation to best meet the intent of the adaptive management Plan.

The current rate and extent of mangrove and "white zone" expansion and surface/groundwater intrusion into the southern coastal wetlands is not known. Analyses of historic and current databases and/or aerial photos to determine the current rate and extent of mangrove and "white zone" expansion and surface/groundwater intrusion are necessary to set the baseline condition for CEPP. Annual vegetation transects, landscape scale aerial vegetation mapping every 5 years, quarterly porewater conductivity and below ground resistivity, monthly groundwater conductivity, and continuous surface water conductivity in areas of concern (e.g. Model Lands to Lostman's River) beginning with construction of the first feature and/or operational change and carried through O/M is necessary to document any changes to the vegetation distribution and the location of the surface/ground saltwater wedge resulting from incremental increase in deliveries past Tamiami Trail with each constructed feature.

Studies are needed prior to the completion of construction and operation of CEPP features to better understand the interaction of surface and groundwater conductivity on plant growth and soil decomposition processes in the southern coastal wetlands. This information is necessary to determine the rate of soil elevation change. Annual soil elevation and depth monitoring in the areas of concern (e.g. Model Lands to Lostman's River) beginning with construction of the first feature and/or operational change and carried through O/M is necessary to document any change in the rate of soil elevation resulting from incremental increase in deliveries past Tamiami Trail with each constructed feature.
Studies are needed prior to the completion of construction and operational features of CEPP to better understand the effects of the groundwater salt wedge on phosphorus release to surface waters in the southern coastal wetlands. This information is necessary to understand the extent and magnitude of the phosphorus pool. Quarterly soil phosphorus, surface and groundwater conductivity, and below ground resistivity in the areas of concern (e.g. Model Lands to Lostman's River) beginning with construction of the first feature and/or operational change and carried through O/M is necessary to document any change in the rate and extent of phosphorus mobilization resulting from incremental increase in deliveries past Tamiami Trail with each constructed feature.

Triggers/thresholds that indicate good CEPP performance or need for adaptive management action.
The restoration target triggers and baseline threshold for the implementation of adaptive management measures for the region are listed below. Non-attainment of any one of the restoration targets and/or exceedence of any one of the baseline thresholds necessitates the implementation of the adaptive management measures. These triggers and threshold are based on the best professional judgment of scientists familiar with the region, actual environmental monitoring data, modeled scenario data, and scientific research. Refinements or additions to the listed triggers and thresholds may occur in the future as new research and data are analyzed and incorporated by the PDT. Data analyses of existing conditions as referenced below may be found in the CERP RECOVER System Status Reports. Additional data analyses may need to be performed prior to any CEPP construction or operational change to determine existing conditions from pre-construction collected monitoring information.

CEPP Restoration Target Triggers:

- Alteration of current spatial distribution of soil and vegetation nutrient pools relative current conditions
- Increase in the rate of mangrove expansion in the white zone
- Increase in soil loss and/or elevation reduction
- Change in spatial extent of wetland surface water or groundwater salinity relative to two similar rainfall years from the period of record

Baseline Thresholds:

- Movement of spatial nutrient front or increase in nutrient rate of release from soils as observed along soil and/or vegetation transect
- White zone expansion rate exceeds Ross rate (3 km/50 yr west of US1, 1km/50 yr east of US1) and mangrove zone expansion rate exceeds current rate of expansion
- Increase in rate of coastal soil loss over the existing rate
- Magnitude of wetland surface or groundwater salinity exceeds equivalent rainfall conditions for the past 2 years from the period of record
- Inland movement of the saltwater wedge from current location

Management options that may be chosen based on test results.
Suggested Adaptive Management Options listed below are not in any particular order and can be implemented simultaneously, as appropriate.

1. Spatial redistribution of water into less sensitive areas
2. Reduce point source discharges (e.g., S12A, S12B, S12C, S12D) and shift more water to the Blue-Shanty flowway
3. Redistribution of water to more closely match historic timing of flows to the coastal wetlands and estuaries
4. Refinement of existing hydrologic and hydrodynamic models in the southern coastal wetlands, Florida Bay, and the Lower Southwest Coast
5. Adjustments to operations along Tamiami Trail and the LECSA 2 & 3 SFWMD Canal System to improve water deliveries to Biscayne Bay, Florida Bay, and the Lower Southwest Coast

1.4.3.4 Ecological Food Web

CEPP Uncertainty #65
If salinity is affected by overland flow increases through ENP to Florida Bay, how much benefit is generated for SAV, sportfish, prey, coastal wading birds, and crocodiles? Can operations be adjusted to improve estuarine performance in Florida Bay?

CEPP Objective or Constraint:
Uncertainty #65 is related to the following CEPP objectives:

- Restore seasonal hydroperiods and freshwater distribution to support a natural mosaic of wetland and upland habitat in the Everglades System;
- Improve sheetflow patterns and surface water depths and durations in the Everglades system in order to reduce soil subsidence, the frequency of damaging peat fires, the decline of tree islands, and salt water intrusion;
- Reduce water loss out of the natural system to promote appropriate dry season recession rates for wildlife utilization; and
- Restore more natural water level responses to rainfall to promote plant and animal diversity and habitat function

Region(s). CEPP Uncertainty #65 is focused on the ecological effects of CEPP hydrology as a function of increased freshwater deliveries across Tamiami Trail to Shark River and Taylor Sloughs, Florida Bay, and the Lower Southwest Coast.

Associated CEPP features: The associated CEPP features are:
1. The L-30, L-31N, C-111, LECSA 2 & 3 SFWMD Canal System canals;
2. The S-12 Structures, S-356, G-211, divide and coastal water management structures LECSA 2 & 3 SFWMD Canal System
3. Blue Shanty Flow Way; and
4. The partial seepage barrier south of Tamiami Trail along L-31N.

Driver or uncertainty type: The primary driver for this uncertainty is hydrology.

What is expected to be learned by addressing this uncertainty, i.e., how will CEPP benefit from addressing this uncertainty? The primary hydrologic driver for the ecosystems in Florida Bay and the Lower Southwest Coast is salinity. CEPP is predicted to increase flows to Florida Bay and the Lower Southwest coast resulting in a positive change in the salinity regime. Ecological indicators are also predicted to result in comparable response to the salinity regime. CEPP flows to Florida Bay and the Southwest coast will result in an improved salinity regime resulting in: 1) an increase in the coverage of *Halodule* and *Ruppia* densities and community diversity in the nearshore basins and coastal wetland fringe and 2) improved status of the ecological indicators (e.g. spotted seatrout, pink shrimp, coastal wading birds, and crocodiles).

Expectations or hypotheses to be tested to address uncertainty #, and attribute(s) that will be measured to test each. More Information on attributes to be measured:
- **What is expected to be learned by measuring this attribute, i.e., how will CEPP benefit from knowledge gained about this attribute?**
- **What is the time frame in which changes to this attribute are expected to be measurable?**

- **Is this attribute complimented by other monitoring programs (within and/or outside of CEPP)? If so, provide reference to other monitoring and make sure that monitoring paid for by others is noted in the CEPP adaptive management budget spreadsheet.**
- **When during CEPP's life cycle should this monitoring begin and end?**

Hydrologic and ecologic attributes are selected to monitor the effects of CEPP hydrologic modifications to the volume of freshwater delivery south of Tamiami Trail and the associated ecological responses in Shark River and Taylor Sloughs, Florida Bay, and the Lower Southwest Coast. These attributes were selected based on existing knowledge of 1) surface/groundwater connectivity in Shark River and Taylor Sloughs and adjacent estuaries; and 2) ecological food web dynamics and mechanisms in the region. Many of the attributes listed are currently monitored by other agencies or USACE projects and may provide, in part, input to the testing of this uncertainty's hypothesis. It is anticipated additional monitoring will be necessary for the Project, to be determined during Design. Costs for the additional monitoring have been included in the Monitoring Cost Table. The timeframe in which the attributes listed below will be able to measure changes as function of the Project range from a minimum of 7 days (wetland and canal/stage, surface and groundwater flow) to a maximum of 5 years (juvenile pink shrimp and crocodiles, estuarine fish, Roseate Spoonbills). Estimated timeframes are listed below in parentheses.

The attributes to be measured, along with the timeframe in which changes are expected to be measureable in parentheses, are:

1. Estuarine Salinity (2 years)
2. Estuarine Submerged Aquatic Vegetation (2 years)
3. Juvenile Pink Shrimp and Associated Estuarine Epifauna (5 years)
4. Estuarine Fish (5 years)
5. Roseate Spoonbills (5 years)
6. Juvenile Crocodiles (5 years)
7. Wetland and Canal/Creek Stage (7 days)
8. Surface and Groundwater Flow (7 days)

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting:
More information on what to measure, how, how often, how to analyze, and when and how to report results. PLEASE NOTE: the CEPP Adaptive Management Plan varies in the level of methodology detail provided; in several cases the details will be formed after CEPP design details are known. In ALL cases, methodology will be reviewed, updated and adjusted if needed, by agency subject experts before initiation to best meet the intent of the Adaptive Management Plan.

Real-time analyses of operational changes to the S-12 structures, S-333, and the LECSA 2 & 3 SFWMD Canal System and their subsequent effect on surface and ground water flows to the southern coastal creeks and salinity and ecosystems in Florida Bay and the Lower Southwest Coast prior to construction, during construction, and into O/M for CEPP is necessary to provide feedback to water managers on operational decisions and their subsequent effect on the estuaries. Focus of the analyses are on the distribution, magnitude, and timing of surface and groundwater flows at water management structures, select wetland stage/flow gages, and select coastal creek flow gages; changes to salinity at the Marine Monitoring Network stations; changes in the coverage of *Halodule* and *Ruppia* densities and community diversity in the nearshore basins and coastal wetland fringe; and changes in the status of ecological indicator (e.g. seagrass, spotted seatrout, pink shrimp, coastal wading birds, and crocodiles) species in Florida Bay and the Lower Southwest Coast. Preferably, refinement to couple the existing hydrologic, hydrodynamic, and ecological models in the southern coastal wetlands, Florida Bay, and the Lower

Southwest coast is necessary to better forecast the effects of operational changes on the hydrology and ecology prior to actual implementation and avoid irreversible negative impacts through a trial and error approach.

Triggers/thresholds that indicate good CEPP performance or need for adaptive management action. The restoration target triggers and baseline threshold for the implementation of adaptive management measures for the region are listed below. Non-attainment of any one of the restoration targets and/or exceedence of any one of the baseline thresholds necessitates the implementation of the adaptive management measures. These triggers and threshold are based on the best professional judgment of scientists familiar with the region, actual environmental monitoring data, modeled scenario data, and scientific research. Refinements or additions to the listed triggers and thresholds may occur in the future as new research and data are analyzed and incorporated by the PDT. Data analyses of existing conditions as referenced below may be found in the CERP RECOVER System Status Reports. Additional data analyses may need to be performed prior to any CEPP construction or operational change to determine existing conditions from pre-construction collected monitoring information.

CEPP Restoration Target Triggers:

- RECOVER Southern Coastal Systems Performance Measure: Salinity in Florida Bay (http://www.evergladesplan.org/pm/recover/recover_docs/perf_measures/062812_rec_pm_scs_salinity_flbay.pdf) metrics less than those predicted for the selected alternative (4R2) or exhibits a negative long-term trend at each of the 17 NPS Marine Monitoring Network stations in Florida Bay
- Stage/flow distribution inconsistent to those predicted for the selected alternative (4R2)
- No increase in submerged aquatic vegetation habitat diversity and coverage as predicted for the selected alternative (4R2) in Florida Bay and the Lower Southwest Coast or exhibits a negative long-term trend.
- Juvenile Spotted Seatrout, Juvenile Pink Shrimp, Juvenile Crocodile, and Roseate Spoonbill indicators are less than those predicted by each indicator's respective HSI for the selected alternative (4R2) or exhibits a negative long-term trend

Baseline Thresholds:

- 5% decrease in seagrass, mangrove fish, juvenile pink shrimp, juvenile crocodile, or Roseate Spoonbill spatial coverage and/or species specific densities from existing conditions as a function of upstream hydrologic changes.
- Salinity exceeds the 90th percentile of the recorded salinity values at the NPS Marine Monitoring Network for the NE Florida Bay and nearshore Florida Bay stations for the entire period of record for the equivalent rainfall years.
- Magnitude of wetland surface or groundwater salinity exceeds equivalent rainfall conditions for the past 2 years from the period of record
- Increased frequency of yellow and/or red conditions for the algal bloom, seagrass, juvenile pink shrimp, juvenile crocodile, or Roseate Spoonbill system-wide indicator report
- Violation of the Minimum Flows and Levels for Florida Bay

Management options that may be chosen based on test results. Suggested Adaptive Management Options listed below are not in any particular order and can be implemented simultaneously, as appropriate.

1. Spatial redistribution of water into less sensitive areas

2. Reduce point source discharges (e.g., S12A, S12B, S12C, S12D) and shift more water to the Blue-Shanty flowway
3. Redistribution of water to more closely match historic timing of flows to the coastal wetlands and estuaries
4. Refinement and coupling of existing hydrologic, hydrodynamic, and ecological models in the southern coastal wetlands, Florida Bay, and the Lower Southwest Coast
5. Adjustments to operations along Tamiami Trail and the LECSA 2 & 3 SFWMD Canal System to improve water deliveries to Biscayne Bay, Florida Bay, and the Lower Southwest Coast

1.4.4 Lower East Coast Seepage Management

1.4.4.1 CEPP Effects on LEC Water Supply and Flood Risk Management

The Lower East Coast (LEC) is primarily the area of Miami-Dade County, Florida, although it extends beyond this county to others such as Broward County. It lies on a limestone ridge between the Everglades to the west and Biscayne Bay to the east, and historically was hydrologically connected to both via groundwater and overland flow. Water management activities such as construction of canals and associated flood damage reduction operations, and the transformation of historic wetlands to agriculture or urban land use in the past several decades, have changed the magnitude, distribution, and timing of fresh surface and ground water to the LEC and the associated estuaries of Biscayne Bay, Manatee Bay, Barnes Sound, and Card Sound. The fresh water in the LEC and its associated estuaries are now mostly hydrologically controlled by a network of water management levees, canals, and seepage walls along the eastern border of the Everglades and throughout the LEC. The transitional areas of the southern coastal wetlands of Biscayne Bay, Manatee Bay, Barnes Sound, and Card Sound and the estuaries themselves, constitute some of the most ecologically productive areas in Florida, supporting a portion of Florida's tourism and fishing industry, as well as being considered aesthetically amongst the most beautiful areas in Florida (Ogden 2005, CEPP Ecosystem Services Report **Annex H**). CEPP planning included a constraint in the LEC and associated estuaries for no change in the water supply for both human and natural needs, and flood damage reduction (i.e. "level of service") compared to that currently provided in this economically and aesthetically important area.

CEPP's planning has met legal requirements in this regard through its Savings Clause and Project Assurance Analyses **(Annex B**). However, the questions listed below promote continued investigation, adjustment, and back-checking to confirm that the expected balance is achieved between the existing level of service for the LEC and its associated estuaries and the restoration of the Greater Everglades, Florida Bay, and the Lower Southwest Coast portions of CEPP. The adaptive management opportunities identified here by the CEPP Project Delivery Team will help to inform CEPP's multi-year construction; pre-construction engineering and design (PED) assessments will inform construction steps and potentially lower project costs by reducing the extent of construction needed. The adaptive management opportunities will continue beyond PED for several years after construction in this area. It is expected that normal PED activities will lead to the correct design for the CEPP seepage barrier in this area; the adaptive management activities described below address potential needs that have low probability of occurring but are of high importance to PDT members and stakeholders.

For a detailed analysis of water supply and flood risk management modeling done for this area, see CEPP PIR Annex B: Analysis Required by WRDA 2000 and State Law.

Existing water supply and flood damage reduction for the Lower East Coast of Florida east of the L30, L31-N, and C-111 are considered a constraint on CEPP. The 2.5 million residents of Miami-Dade County's residents rely on the flood protection provided by the Central and Southern Florida Project (C&SF) and the groundwater supply from the Biscayne Aquifer supported by surface and groundwater flows from the greater Everglades. Constructed and operational features of CEPP are expected to be sufficient to maintain the: 1) current level of flood damage reduction provided by the C&SF system, 2) current water supply during the dry season and/or drought periods, 3) current spatial extent of saltwater intrusion at the base of the aquifer, 4) current levels of surface water quality in the canals of the South Dade Conveyance System, and 5) current level of surface water influence on the groundwater in the Miami-Dade Wellfield Protection Areas. However, due to the complexity of the region's hydrology and inevitable modeling uncertainties, the following adaptive management strategies are provided to ensure that CEPP proceeds cautiously and with the most current information available in this area. The strategies and the Implementation section of this adaptive management plan describe how the work will be coordinated, the monitoring programs and data that will be used, and the process for assessing the data and reporting results, and the process for elevating findings and concerns quickly, if needed.

CEPP Uncertainty #35
Will the constructed and operational features of CEPP maintain flood risk management (WS/FRM) level of service east of the L-30, L-31N, L-31W, and C-111 without reducing quantity or quality of groundwater in water supply wellfields compared to existing conditions?

CEPP Objective or Constraint: The CEPP constraint related to this uncertainty is as follows. In accordance with Section 601(h)(5) of WRDA 2000 and Chapter 373.1501(4)(d), Federal Statute (F.S.), the project will:

- Avoid any reduction in level of service for flood protection
- Provide replacement sources of water of comparable quantity and quality for existing legal users caused by Plan implementation

Project constraints were recognized to ensure that the proposed project would not reduce the level of service for flood protection, protect existing legal users, and meet applicable water quality standards for the natural system by providing an incremental increase in water supply to the Lower East Coast Service Area basins that include Broward and Miami-Dade Counties (called LECSA 2 and 3) in the amounts of 12 MGD total annual average to Broward County and 5 MGD total annual average to Miami-Dade County. More detailed description of the project constraints related to flood risk management and water supply are provided in CEPP PIR Annex B.

Region(s). Historically, the Miami-Dade County was hydrologically connected to the Greater Everglades System (e.g. Taylor Slough) to the west of the Miami Rock Ridge and to Biscayne Bay east of the Ridge. Water management activities such as the construction of canals and associated flood control operations, and the transformation of historic wetlands to agriculture or urban land use in the past several decades have changed the magnitude, distribution, and timing of fresh surface and ground water available to Miami-Dade County as a source of freshwater recharge for the Biscayne Aquifer, the only source of water supply for the County. Surface and groundwater flow in Miami-Dade County is now hydrologically controlled by a network of water management features (levees, canals, seepage walls) along the eastern border of ENP and throughout LECSA 2 and 3. The 2.5 million residents of Miami-Dade County rely on the flood protection provided by the LECSA 2 & 3 SFWMD Canal System and the groundwater supply from the Biscayne Aquifer supported by surface and groundwater flows from the greater Everglades.

Associated CEPP features: The associated features are the L-30, L-31N, L-31W, C-111, LECSA 2 & 3 SFWMD Canal System; the S-356 and G-211 divide and coastal water management structures of the LECSA 2 & 3 SFWMD Canal System; and the CEPP partial seepage barrier south of Tamiami Trail along L-31N.

Driver or uncertainty type: The primary driver for this uncertainty is hydrology.

What is expected to be learned by addressing this uncertainty, i.e., how will CEPP benefit from addressing this uncertainty? The expectations or hypotheses listed below promote “back-checking” to confirm that the expected balance is achieved between the existing WS/FRM level of service for Miami-Dade County and the restoration of the Greater Everglades, Florida Bay, and the Lower Southwest Coast. The CEPP

Project Delivery Team has identified opportunities to learn during CEPP's multi-year construction. These lessons learned could inform remaining construction steps and potentially lower project costs by reducing the extent of construction needed.

CEPP will not reduce the WS/FRM level of service to LECSA 2 and 3 and will provide an incremental increase in water supply to the LECSA 2 and 3 in the amounts of 12 MGD (total annual average) to Broward County and 5 MGD (total annual average) to Miami-Dade County. The 2.5 million residents of Miami-Dade County's residents rely on the flood protection provided by the LECSA 2 & 3 SFWMD Canal System and the groundwater supply from the Biscayne Aquifer supported by surface and groundwater flows from the greater Everglades. Constructed and operational features of CEPP are sufficient to maintain the: 1) current level of flood protection provided by the C&SF system, 2) dry season (permitted) pumpage volume for water supply east of the L-30/L-31N without significant drawdown of the Biscayne Aquifer. "Significant drawdown" is to be defined during the PED phase of CEPP in close coordination with interested stakeholders, 3) current spatial extent of saltwater intrusion at the base of the aquifer, 4) current levels of surface water quality in the canals of the LECSA 2 & 3 SFWMD Canal System, and 5) current level of surface water influence on the groundwater in the Miami-Dade Wellfield Protection Areas.

Expectations or hypotheses to be tested to address uncertainty #, and attribute(s) that will be measured to test each.
More Information on attributes to be measured:

- ***What is expected to be learned by measuring this attribute, i.e., how will CEPP benefit from knowledge gained about this attribute?***
- ***What is the time frame in which changes to this attribute are expected to be measurable?***
- ***Is this attribute complimented by other monitoring programs (within and/or outside of CEPP)? If so, provide reference to other monitoring and make sure that monitoring paid for by others is noted in the CEPP adaptive management budget spreadsheet.***
- ***When during CEPP's life cycle should this monitoring begin and end?***

CEPP Uncertainty #35 is focused on the hydrologic modifications, both structural and operations, to the flood control function of the LECSA 2 & 3 SFWMD Canal System and the potential effects on the quality and quantity of water supply for Miami-Dade County. Addressing this uncertainty will help CEPP meet WS/FRM requirements by informing the detailed design of the CEPP seepage barrier. Informing the detailed design may bring cost savings by reducing the proposed size of the seepage barrier or potentially, show the barrier is not needed. If the barrier is needed, a post-construction component has been included as a check for unintended impacts.

Pre-construction A: Verify whether a CEPP seepage barrier is needed. Studies are needed utilizing MODFLOW groundwater models that have been used routinely for seepage evaluations in the area. Existing models may be improved, where needed, with existing leveraged monitoring data. Attributes to evaluate include, but are not limited to: water level, stage, hydroperiod, and seepage flux. Modeling efforts may take up to 6 months to refine and focus on the area(s) and parameter(s) of interest.

Pre-construction B: If CEPP seepage barrier is needed, determine depth and extent needed. Studies are needed during the PED phase of the project to incorporate configuration and permeability information from the Rock Mining seepage barrier along with additional information on hydrology and water quality to be collected during the geotechnical analysis and subsurface investigations that are normally completed during the PED phase of the project at least 3 years prior to construction of the seepage barrier. Attributes to evaluate include, but are not limited to: existing seepage barrier configuration and permeability data including the Rock Mining seepage barrier data, USGS hydrogeologic reports (for example, Cunningham, K.J. and M.C. Sukop, 2001), and exploratory bore holes as necessary per USACE PED protocols.

Post-construction:
If data shows that CEPP seepage barrier shifts seepage to area north of the L-31N, the CEPP PDT may determine that the seepage barrier should be extended north of L-31N/Tamiami Trail (along the "triangle area"). Trigger or justification for this decision would be if monitoring data shows continued need to capture WCA 3B eastward seepage in this area. This will be determined by assessing whether seepage increases to the L30 or L29, which would indicate that there is increased seepage north of Tamiami Trail that may need to be addressed.

Hydrologic and water quality attributes are selected to measure the effects of CEPP hydrologic structural modifications to the L-30, L-31N, L-31W, and C-111 canals and operation of the LECSA 2 & 3 SFWMD Canal System on the quantity and quality of the groundwater available for water supply for Miami-Dade County. These attributes were selected based on existing knowledge of surface/groundwater connectivity in Miami-Dade County. Many of the attributes listed are currently monitored by other agencies or USACE projects and may provide, in part, input to the testing of this uncertainty's hypothesis. It is anticipated additional monitoring will be necessary for the Project and that the monitoring suggested here will be reviewed during CEPP Design to adjust to potential needs or changes in data availability that may occur after publication of this adaptive management plan. Costs for the proposed monitoring have been included in the Monitoring Cost Table. The timeframe in which the attributes listed below will be able to measure changes as function of the Project range from a minimum of 7 days (wetland and canal stage/flow) to a maximum of 2 years (estuarine salinity). Estimated timeframes are listed below in parentheses.

The attributes to be measured are:

1. Wetland and Canal/Creek Stage (7 days)
2. Surface and Groundwater Flow (7 days)
3. Wetland Surface and Groundwater Salinity (1 year)
4. Surface and Groundwater Quality (2 months)
5. Estuarine Salinity (2 years)

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting:
More information on what to measure, how, how often, how to analyze, and when and how to report results. PLEASE NOTE: the CEPP Adaptive Management Plan varies in the level of methodology detail provided; in several cases the details will be formed after CEPP design details are known. In ALL cases, methodology will be reviewed, updated and adjusted if needed, by agency subject experts before initiation to best meet the intent of the Adaptive Management Plan.

Pre-construction A: At the time of publishing this adaptive management plan, the extent of seepage management that CEPP will need to achieve is not determined due to ongoing and proposed seepage barrier and operational testing in the area; the seepage barrier proposed in the CEPP TSP is sufficient to meet project constraints without the test barrier that has recently been installed. The actual CEPP seepage barrier may not need to be as extensive as that proposed in the TSP. Real-time analyses of structural changes by the rock miner installed seepage barrier, S-356 pump station, and operational changes to the LECSA 2 & 3 SFWMD Canal System and their subsequent affect on surface and ground water flows east of the L29, L30, L31-N, and C-111 is necessary prior to CEPP construction to provide adaptive management feedback to the CEPP PDT on the efficacy of a seepage barrier and its subsequent effects on flood risk management and water supply for the Lower East Coast. The evaluation may follow routine methods for seepage evaluations and incorporate specific suggestions from agencies and stakeholders based on knowledge gained from the Rock Mining seepage barrier and other activities in the region.

Pre-construction B: Technical analysis to incorporate configuration and permeability information from the Rock Mining seepage barrier along with additional information on hydrology and water quality to be collected during the geotechnical analysis and subsurface investigations to further develop the design of CEPP's seepage wall.

Post-construction:
Real-time analyses of structural changes by the CEPP installed seepage barrier and operational changes to the LECSA 2 & 3 SFWMD Canal System and their subsequent affect on surface and ground water flows east of the L29, L30, L31-N, L-31W, and C-111 during construction and into O/M for CEPP is necessary to provide feedback to water managers on operational decisions and their subsequent effect on flood control and water supply for the Lower East Coast. Focus of the analyses are on: 1) the distribution, magnitude, and timing of surface and groundwater flows and stage elevation at water management structures and select wetland stage/flow gages; 2) surface and ground water quality monitoring at select locations in: the LECSA 2 & 3 SFWMD Canal System, areas of concern throughout Miami-Dade County associated with the public wellfields, and areas of concern along the saltwater intrusion line for Miami-Dade County; and 3) possible seepage increases to the L29 or L30, which would indicate that there is increased seepage north of Tamiami Trail that may need to be addressed. Team will then need to decide if the increased seepage is a problem, i.e., canal stages exceeding mandated levels. Preferably, refinement of the existing hydrologic and hydrodynamic models for the Lower East Coast is necessary to better forecast the effects of constructed features and operational changes prior to actual implementation and avoid irreversible negative impacts through a trial and error approach.

Triggers/thresholds that indicate good CEPP performance or need for adaptive management action. The baseline thresholds for the implementation of adaptive management measures for the region are listed below. Exceedence of any one of the baseline thresholds necessitates the implementation of the adaptive management measures. These threshold limits are based on the Savings Clause; requirements of Consumptive Use Permits issued for the LEC; Chapter 62-302, F.A.C.: Surface Water Quality Standards; Chapter 62-303, F.A.C.: Impaired Waters Rule; Chapter 62-520, F.A.C.: Ground Water Quality Standards; Chapter 40E-8 F.A.C.: Minimum Flows and Levels Rules; SFWMD proposed Water Reservations Rule for the CERP Biscayne Bay Coastal Wetlands Project – Phase 1; and best professional judgment of scientists familiar with the region. Refinements or additions to the listed triggers and thresholds may occur in the future as new and/or updated research, Standards, Permits, or Rules and data are analyzed and incorporated by the PDT. Data analyses of existing conditions as referenced below may be found in the CERP RECOVER System Status Reports. Additional data analyses may need to be performed prior to any CEPP construction or operational change to determine existing conditions from pre-construction collected monitoring information.

Baseline Thresholds:
General:

- Magnitude of wetland surface or groundwater salinity exceeds equivalent rainfall conditions for the past 2 years from the period of record
- Inland movement of the saltwater wedge from current location

- Greater than 1% decrease in canal flow and/or stages compared to existing April conditions and/or in dry years
- Violation of existing Consumptive Use Permit requirements
- Increase of 1% or greater in canal or groundwater stage compared to existing October average water table
- Violation of Chapter 62-305 or 62-520, F.A.C. for various surface and groundwater quality parameters
- Increased frequency or magnitude of exceedences in surface water monitoring segments that would lead to designation of "impaired" per Chapter 62-303, F.A.C.
- Declining trend in surface or groundwater quality compared to prior condition
- Detection of indicators of surface water influence in groundwater monitoring wells.

L-29 and L-30:

- Increased levels of seepage in the L-29 and L-30 as a function of the CEPP seepage barrier resulting in canal stages exceeding mandated levels.
- Stage in WCA 3B exceeds the maximum design criteria for the L-30 East Coast Protective Levee.
- RECOVER Greater Everglades Performance Measure: Sheet flow in the Everglades Ridge and Slough Landscape (http://www.evergladesplan.org/pm/recover/recover_docs/et/ge_sheetflow_01.pdf) metrics less than those predicted for the selected alternative (4R2) or exhibits a negative long-term trend at Transects 16 (East WCA-3B) and 18 (Tamiami Trail East)

Dry season pumping:

- Suggested for consideration based on maximum aquifer drawdown limits for the Biscayne Bay Aquifer per the Consumptive Use Permit: Threshold limit of 2 feet of drawdown within the cone of influence of any of the Miami-Dade public water supply wells during the dry season.

Management options that may be chosen based on test results. Suggested Adaptive Management Options listed below are not in any particular order and some can be implemented simultaneously, as appropriate.

- Adjustments to operations in the L-30, L-31N, C-111, and the LECSA 2 & 3 SFWMD Canal System to improve water deliveries to the Biscayne Bay, Manatee Bay, Barnes Sound, and Card Sound
- Refinement and coupling of existing hydrologic and hydrodynamic in the LECSA 2 & 3, Biscayne Bay, Manatee Bay, Barnes Sound, and Card Sound to improve ability to forecast effects of structures and operations to avoid costly trial and error
- Coordinated operational test scenarios prior to conveyance of “new water” of existing S-356 pump station, Modified Waters Deliveries detention features, and existing barrier wall and G-211, during wet season/storm events and during the dry season to develop data on marsh, canal and groundwater stages (including in reference areas) and structure flows to assess effectiveness of components in maintaining wetland hydrologic targets, without adversely affecting flood protection or affecting water supply. Specifically assess ability to maintain canal stages as specified in existing water use permits in water supply wellfields near the L-30/31.
- Develop dry season/drought condition operational plan, similar to "prestorm drawdown" operational plan. Refinement of standard ERTP or regional operating plans, as necessary, including schedule of S-356 and G-211 operations.

- Additional targeted modeling, using more detailed data above, to evaluate need for additional segments of barrier wall or increases in pump capacity to control seepage expected from expected increased flows to WCA 3B and NE Shark River Slough.
- Dry season pumping: Hold water higher in WCA 3B to increase head to push water under the seepage barrier.
- Dry season pumping: Retain water in WCA 3B and ENP during dry season by adjusting operations to send more water east of L-30/L-31N
- Dry season pumping and L-29/L-30: Initiate discussions with stakeholders on how to continue level of service for LEC water supply while avoiding ecological impacts in WCA 3B.
- L29/L30: Hydraulic analysis of levee stability with the increased average stages in WCA 3B. (This may be done as part of the ongoing National Levee System updated data base.) Determine if reinforcing the levee would allow for higher stages, if such stages would benefit CEPP.
- L29/L30: Install hydraulic pass-throughs (windows) in the seepage barrier to increase flow across seepage barrier and reduce increased seepage to the north.
- L29/L30: Adjust operations to route the water to locations where it is needed, rather than sending the water to tide.
- L29/L30: Extension of the CEPP seepage barrier to the north of Tamiami Trail.

1.4.4.2 CEPP Hydrologic Effects on Lower East Coast Ecosystems

CEPP Uncertainty #62
Will the constructed and operational features of CEPP reduce surface and/or groundwater base flows and wetland/groundwater recharge to the east of the L-30 and L31-N in areas such as the Pennsuco Wetlands, south Miami-Dade wetlands, and Biscayne Bay?

CEPP Objective or Constraint: In accordance with Section 601(h)(5) of WRDA 2000 and Chapter 373.1501(4)(d), Federal Statute (F.S.), the project will:

- Avoid any reduction in level of service for flood protection existing as of December 2000 caused by Plan implementation
- Provide replacement sources of water of comparable quantity and quality for existing legal users caused by Plan implementation

Project constraints were recognized to ensure that the proposed project would not reduce the level of service for flood protection, protect existing legal users (to include water supply for fish and wildlife in Biscayne Bay), and meet applicable water quality standards for the natural system by providing an incremental increase in water supply to the LECSA 2 and 3 in the amounts of 12 MGD (total annual average) to Broward County and 5 MGD (total annual average) to Miami-Dade County and at the same time, meet applicable Water Quality Standards.

Region(s). CEPP Uncertainty #62 is focused on the ecological effects of CEPP hydrology as a function of the fresh surface and groundwater flows throughout the inland portions of Miami-Dade County and their input to Biscayne Bay, Manatee Bay, Barnes Sound, and Card Sound.

Associated CEPP features: The associated CEPP features are:

1. The L-30, L-31N, C-111, LECSA 2 & 3 SFWMD Canal System;
2. The S-356, G-211, divide and coastal water management structures of the LECSA 2 & 3 SFWMD Canal System; and

3. The partial seepage barrier south of Tamiami Trail along L-31N.

Driver or uncertainty type: The primary driver for this uncertainty is hydrology.

What is expected to be learned by addressing this uncertainty, i.e., how will CEPP benefit from addressing this uncertainty? The Pennsuco Wetlands provide groundwater recharge to the Northwest Wellfield public water supply for Miami-Dade County. These wetlands along with other wetlands and designated conservation lands east of the L30, L-31N, and C-111 canals provide essential habitat to many native floral and faunal species. Biscayne Bay is the estuary immediately east of Miami-Dade County and is a Florida Outstanding Water and has within its boundaries Oleta River and Bill Baggs-Cape Florida State Parks, the Biscayne Bay Aquatic Preserve, state-designated critical wildlife areas (e.g. Virginia Key), Biscayne National Park, and the Florida Keys National Marine Sanctuary. Constructed and operational features of CEPP are sufficient to maintain the current level surface and groundwater base freshwater flows to both the Pennsuco Wetlands and Biscayne Bay to where there is no change in the ecological conditions of these two areas.

Expectations or hypotheses to be tested to address uncertainty #, and attribute(s) that will be measured to test each. More Information on attributes to be measured:

- **What is expected to be learned by measuring this attribute, i.e., how will CEPP benefit from knowledge gained about this attribute?**
- **What is the time frame in which changes to this attribute are expected to be measurable?**
- **Is this attribute complimented by other monitoring programs (within and/or outside of CEPP)? If so, provide reference to other monitoring and make sure that monitoring paid for by others is noted in the CEPP adaptive management budget spreadsheet.**
- **When during CEPP's life cycle should this monitoring begin and end?**

Hydrologic and ecologic attributes are selected to measure the effects of CEPP hydrology on the ecosystems of the region (inland portions of Miami-Dade County, Biscayne Bay, Manatee Bay, Barnes Sound, and Card Sound). These attributes were selected based on existing knowledge of 1) surface/groundwater connectivity in the LEC and adjacent estuaries and 2) wetland and estuarine species and habitat status and function. Many of the attributes listed are currently monitored by other agencies or USACE projects and may provide, in part, input to the testing of this uncertainty's hypothesis. It is anticipated additional monitoring will be necessary for the Project, to be determined during Design. Costs for the additional monitoring have been included in the Monitoring Cost Table. The timeframe in which the attributes listed below will be able to measure changes as function of the Project range from a minimum of 7 days (wetland and canal stage/flow) to a maximum of 5 years (juvenile pink shrimp and associated epifauna and fish). Estimated timeframes are listed below in parentheses.

The attributes to be measured are:

1. Estuarine Salinity (2 years)
2. Estuarine Submerged Aquatic Vegetation (2 years)
3. Juvenile Pink Shrimp and Associated Estuarine Epifauna (5 years)
4. Estuarine Fish (5 years)
5. Wetland and Canal/Creek Stage (7 days)
6. Surface and Groundwater Flow (7 days)
7. Wetland Surface and Groundwater Salinity (1 year)
8. Surface and Groundwater Quality (2 months)
9. Wetland Vegetation (1 year)

Methodology for testing each expectation or hypothesis (including frequency of monitoring) and for reporting: *More information on what to measure, how, how often, how to analyze, and when and how to report results. PLEASE NOTE: the CEPP Adaptive Management Plan varies in the level of methodology detail provided; in several cases the details will be formed after CEPP design details are known. In ALL cases, methodology will be reviewed, updated and adjusted if needed, by agency subject experts before initiation to best meet the intent of the Adaptive Management Plan.*

Real-time analyses of structural changes by the rock miner installed seepage barrier, S-356 pump, and operational changes to the LECSA 2 & 3 SFWMD Canal System and their subsequent affect on surface and ground water flows and the ecosystems east of the L30, L31-N, and C-111 and into Biscayne Bay is necessary prior to CEPP construction to provide adaptive management feedback to CEPP on the efficacy of a seepage barrier and its effects on the ecological conditions of the Pennsuco Wetlands and Biscayne Bay. Real-time analyses of structural changes by the CEPP installed seepage barrier and operational changes to the LECSA 2 & 3 SFWMD Canal System and their subsequent affect on surface and ground water flows and the ecosystems east of the L30, L31-N, and C-111 and into Biscayne Bay during construction and into O/M for CEPP is necessary to provide feedback to water managers on operational decisions and their subsequent effect on the ecological conditions of the Pennsuco Wetlands and Biscayne Bay. Focus of the analyses are on: 1) the distribution, magnitude, and timing of surface and groundwater flows and stage elevation at water management structures and select wetland stage/flow gages; 2) salinity at the Marine Monitoring Network and other select stations in Biscayne Bay; 3) wetland vegetation condition and status in the Pennsuco Wetlands and other wetlands east of the L-31N and C-111; and 4) seagrass and along shore epifauna and fish condition and status in Biscayne Bay. Preferably, refinement and coupling of the existing hydrologic, hydrodynamic, and ecological models for LECSA 2 & 3 and Biscayne Bay is necessary to better forecast the effects of operational changes prior to actual implementation and avoid irreversible negative impacts through a trial and error approach.

Triggers/thresholds that indicate good CEPP performance or need for adaptive management action. *Triggers or thresholds are a point, range, or limit that signifies when restoration performance is veering away from expectations and is trending toward an unintended outcome. Triggers/thresholds should be described per attribute to be monitored because each should result in an outcome that informs management decisions.*

The baseline threshold for the implementation of adaptive management measures for the region are listed below. Exceedence of any one of the baseline thresholds necessitates the implementation of the adaptive management measures. These threshold limits are based on the Savings Clause; requirements of Consumptive Use Permits issued for the LEC; Chapter 62-302, F.A.C.: Surface Water Quality Standards; Chapter 62-303, F.A.C.: Impaired Waters Rule; Chapter 62-520, F.A.C.: Ground Water Quality Standards; Chapter 40E-8 F.A.C.: Minimum Flows and Levels Rules; SFWMD proposed Water Reservations Rule for the CERP Biscayne Bay Coastal Wetlands Project – Phase 1; and best professional judgment of scientists familiar with the region. Refinements or additions to the listed triggers and thresholds may occur in the future as new and/or updated research, Standards, Permits, or Rules and data are analyzed and incorporated by the PDT. Data analyses of existing conditions as referenced below may be found in the CERP RECOVER System Status Reports. Additional data analyses may need to be performed prior to any CEPP construction or operational change to determine existing conditions from pre-construction collected monitoring information.

Baseline Thresholds:

- 5% decrease in seagrass, mangrove fish, juvenile pink shrimp, or select wetland vegetation spatial coverage and/or species specific densities from existing conditions as a function of upstream hydrologic changes.

- Salinity exceeds the 90th percentile of the recorded salinity values at the NPS Marine Monitoring Network nearshore Biscayne Bay stations for the entire period of record for the equivalent rainfall years.
- Magnitude of wetland surface or groundwater salinity exceeds equivalent rainfall conditions for the past 2 years from the period of record
- Inland movement of the saltwater wedge from current location.
- Greater than 1% decrease in canal flow and/or stages compared to existing April conditions and/or in dry years
- Greater than 1% decrease in average annual flows to Biscayne Bay through the coastal structures
- Violation of existing Consumptive Use Permit requirements
- Increase of 1% or greater in canal or groundwater stage compared to existing October average water table
- Violation of Chapter 62-305 and 62-520, F.A.C. for various surface and groundwater quality parameters
- Increased frequency or magnitude of exceedences in surface water monitoring segments that would lead to designation of "impaired" per Chapter 62-303, F.A.C.
- Declining trend in surface or groundwater quality compared to prior condition
- Detection of indicators of surface water influence in groundwater monitoring wells.

Management options that may be chosen based on test results. Suggested Adaptive Management Options listed below are not in any particular order and can be implemented simultaneously, as appropriate.

- Adjustments to operations in the L-30, L-31N, C-111, and the LECSA 2 & 3 SFWMD Canal System to improve water deliveries to Biscayne Bay, Manatee Bay, Barnes Sound, and Card Sound
- Refinement and coupling of existing hydrologic, hydrodynamic, and ecological models in the LECSA 2 & 3, Biscayne Bay, Manatee Bay, Barnes Sound, and Card Sound
- Redistribution of water to more closely match existing flow volumes and to more closely match historic timing of flows to Biscayne Bay.
- Coordinated operational test scenarios prior to conveyance of “new water” of existing S-356 pump station, Modified Waters Deliveries detention features, and existing barrier wall and G-211, during wet season/storm events and during the dry season to develop data on marsh, canal and groundwater stages (including in reference areas) and structure flows to assess effectiveness of components in maintaining wetland hydrologic targets, without adversely affecting flood protection or affecting water supply. Specifically assess ability to maintain canal stages as specified in existing water use permits in water supply wellfields near the L-30/31.
- Develop dry season/drought condition operational plan, similar to "prestorm drawdown" operational plan. Refinement of standard ERTP or regional operating plans, as necessary, including schedule of S-356 and G-211 operations.
- Additional targeted modeling, using more detailed data above, to evaluate need for additional segments of barrier wall or increases in pump capacity to control seepage expected from expected increased flows to WCA 3B and NESRS.

Table D.1.9: Southern Coastal Systems Management Options Matrix

Uncertainty	Time to detect change of attribute/ indicator	Attribute/Indicator	Specific Property to be Measured and Frequency	Decision Criteria: Confirmation of CEPP Performance or Trigger(s) for Management Action	Management Action Option(s)
63	2 Months	Periphyton (nutrient availability)	• periphyton tissue nutrient content, quarterly • soil nutrient, every 2 years	• Alteration of current spatial distribution relative to current conditions • Increased frequency of yellow and/or red conditions for the periphyton nutrient content system-wide indicator report	• Adjust operations to change *spatial* and /or *temporal* distribution of water • Model refinement and coupling to improve ability to forecast effects of operations and adaptive operational changes
63	2 Month	Algal bloom (surface water quality)	• water quality, monthly	• Alteration of current surface water nutrient spatial distribution or concentrations relative to current conditions • Increased frequency of yellow and red conditions for the algal bloom system-wide indicator report	
63	2 years	Cattail (vegetation change)	• vegetation transects, annually • aerial landscape analysis every 5 years	• Alteration of current spatial distribution relative to current conditions • Increased rate of cattail expansion above current rate.	
63, 64	5 years	Soil nutrients (transport & availability)	• Soil and vegetation nutrient transects, bi-annually • soil P, quarterly	• Movement of spatial nutrient front or increase in nutrient rate of release from soils	
35, 61, 62, 65, 67	2 years	Salinity (estuarine)	• Salinity, continuously	• RECOVER Southern Coastal Systems Performance Measure: Salinity in Florida Bay metrics less than those predicted for the selected alternative (4R2) or exhibits a negative long-term trend at each of the 17 NPS MMN stations in Florida Bay • Salinity exceeds the 90th percentile of the recorded salinity values at the MMN NE Florida Bay and near shore Biscayne and Florida Bay stations for the entire period of record for the equivalent rainfall years.	
61, 65, 67	7 days	Stage/Flow	• Stage and/or flow, continuous	• Distribution inconsistent to those predicted for the selected alternative (4R2) • Exceed a 1% reduction in flow to Biscayne Bay relative to current conditions • Violation of the Minimum Flows and Levels for Florida Bay.	
64	5 years	Mangrove and white zone (vegetation change)	• vegetation transects, annually • aerial landscape analysis every 5 years	• White zone expansion rate exceeds Ross rate (3 km/50 yr west of US1, 1 km/50 yr east of US1) • mangrove zone expansion rate exceeds current rate of expansion.	
64	5 years	Soil elevation	• soil elevation and depth, annually	• Reduction in elevation • Increase in rate of coastal soil loss over the existing rate.	
35, 62, 64	1 year	Salinity (wetland surface and groundwater)	• surface water conductivity, continuously • groundwater conductivity, monthly • porewater conductivity and below ground resistivity, quarterly	• Change in spatial extent of wetland surface water or groundwater salinity relative to two similar rainfall years from the period of record • Salinity magnitude exceeds equivalent rainfall conditions for the past 2 years from the period of record) and/or saltwater wedge movement inland.	
62, 65	2 years	Seagrass	• seagrass densities and community diversity, quarterly	• No increase in seagrass habitat diversity and coverage as predicted for the selected alternative (4R2) in Florida Bay and the Lower Southwest Coast • 5% decrease in seagrass coverage and/or species specific densities from existing conditions function of upstream hydrologic changes.	
65	5 years	Spoonbills	• Spoonbill system-wide ecological indicator parameters, annually	• Spoonbill HSI is less than what is predicted for the selected alternative (4R2) or exhibits a negative long-term trend • Increased frequency of 'yellow' and 'red' status for the Roseate Spoonbill in the system-wide indicator report. • 5% decrease in spoonbill densities from existing conditions as a function of upstream hydrologic changes.	
62, 65	5 years	Fish	• Juvenile Seatrout system-wide ecological indicator parameters, annually	• Juvenile Seatrout HSI is less than what is predicted for the selected alternative (4R2) or exhibits a negative long-term trend • Increased frequency of yellow and red for the fish and macroinvertebrates system-wide indicator report for Florida Bay • Salinity exceeds the 90th percentile of the recorded salinity values at the MMN Florida Bay stations for the entire period of record for the equivalent rainfall years • In Florida Bay, 5% decrease in juvenile seatrout spatial coverage and/or species specific densities from existing	

Uncertainty	Time to detect change of attribute/ indicator	Attribute/Indicator	Specific Property to be Measured and Frequency	Decision Criteria: Confirmation of CEPP Performance or Trigger(s) for Management Action	Management Action Option(s)
				conditions as a function of upstream hydrologic changes.	
62, 65	5 years	Pink Shrimp and other epifauna	• Pink Shrimp system-wide ecological indicator parameters, annually	• Juvenile Pink Shrimp HSI is less than what is predicted for the selected alternative (4R2) or exhibits a negative long-term trend • Increased frequency of yellow and red for the juvenile pink shrimp system-wide indicator report for Florida Bay • Salinity exceeds the 90th percentile of the recorded salinity values at the MMN Florida Bay stations for the entire period of record for the equivalent rainfall years • In Florida Bay, 5% decrease in juvenile pink shrimp spatial coverage and/or species specific densities from existing conditions as a function of upstream hydrologic changes.	• Adjust operations to change *spatial* and/or *temporal* distribution of water • Model refinement and coupling to improve ability to forecast effects of operations and adaptive operational changes
65	5 years	Juvenile Crocodiles	• Juvenile growth and survival system-wide ecological indicator parameters, annually	• Juvenile Crocodile HSI is less than what is predicted for the selected alternative (4R2) or exhibits a negative long-term trend • Increased frequency of yellow and red for the crocodilians system-wide indicator report for Florida Bay • 5% decrease in juvenile crocodile growth and survival from existing conditions as a function of upstream hydrologic changes.	
59	1 month	Invasive exotic vegetation and animals	• Vegetation, monthly or seasonally • Animals, daily or seasonally *Per Invasive Species Monitoring Plan	• No new introductions of invasive exotic species into area • Suppression of established invasive species to the lowest feasible level such that ecosystem impacts are minimized • Management decisions based on Florida Weed Risk Assessment Tool, biological profiles and risk assessments (animals) using ECISMA and FWC approach. Trigger is a function of K vs. R-selection by the invasive species.	• Refinement or development of Invasive Species Risk Assessment Tools • Implement CEPP Invasive Species Management Plan measures • CEPP invasive and nuisance species management team may provide information to reduce future species management costs by redesigning or retrofitting project features. If the suggestions are beyond the scope of the CEPP Plan, additional authorization would be required.
35, 62	7 days	LEC Stage/Flow	• stage and/or surface/groundwater flow monitoring, continuous	• Exceed a 1% reduction in flow to Biscayne Bay relative to current conditions • Violation of the Minimum Flows and Levels for Florida Bay; greater than 1% decrease in canal flow and/or stages compared to existing April conditions and/or in dry years • violation of existing consumptive use permit requirements • Increase of 1% or greater in canal or groundwater stage compared to ECB October average water table.	• Operational tests • Develop/refine operational plans • Model development/refinement
35, 62	2 Month	LEC Water Quality (ground and surface)	• water quality, monthly	• Violation of FAC 62-160 for various water quality parameters • increased frequency or magnitude of exceedences in surface water monitoring segments that would lead to designation of "impaired" • Declining trend compared to prior condition • Detection of indicators of surface water influence in groundwater monitoring wells.	• Adjust operations to change *quantity* of water delivered
62	1 Year	LEC Wetland Vegetation	• vegetation transects, annually • aerial landscape analysis every 5 years during construction and into O/M.	• Exceed a 1% reduction in flow to Biscayne Bay relative to current conditions • Violation of the Minimum Flows and Levels for Florida Bay • greater than 1% decrease in canal flow and/or stages compared to existing April conditions and/or in dry years • violation of existing consumptive use permit requirements • Increase of 1% or greater in canal or groundwater stage compared to ECB October average water table • 5% reduction in spatial coverage and/or species specific densities from existing conditions as a function of upstream hydrologic changes.	• Operational tests • Develop/refine operational plans • Model development/refinement

1.5 Implementation of CEPP Adaptive Management

Adaptive management provides an interdisciplinary, integrated, structured process for lowering risk, increasing certainty and informing decisions. For adaptive management to be successful in ensuring the delivery of intended benefits and avoid unintended negative impacts of CEPP, adaptive management activities should continue beyond project planning for the entire project-life cycle from completion of the PIR through all aspects of monitoring, engineering, design, construction, operations, and maintenance components. In addition, mechanisms must be in place to collect, manage, analyze, synthesize, coordinate, and integrate new information into management decisions. Adaptive management implementation can only succeed when decision makers have sufficient funding and staffing resources to implement the adaptive management and monitoring plans. In addition, success requires political and stakeholder support to implement the adaptive management decision methodology and to adjust management decisions based on what is learned.

Per the Programmatic Regulations for the Comprehensive Everglades Restoration Plan (2003), an adaptive management process has been developed for CERP that guides system-wide CERP adaptive management and project level adaptive management (CGM 56 2010; RECOVER 2011b). This detailed CERP guidance adheres to WRDA 2007 and the WRDA 2007 implementation guidance provided by USACE in 2009 in that it focuses on using monitoring information to inform projects and project components by resolving uncertainties and providing mechanisms to efficiently incorporate new knowledge in project planning, design, and implementation. CEPP has and will use this framework to implement adaptive management. Doing so will allow CEPP to both take advantage of and contribute to work being done system-wide and by other projects. Because new information is continually becoming available, CEPP adaptive management and monitoring plan must be recognized as a living document that is improved upon through incorporation of new information. In particular, as each project component is designed and implemented, specific adaptive management strategies and monitoring should be reviewed and adjusted as necessary.

To facilitate implementation of the CEPP Adaptive Management Plan, RECOVER scientists will <u>coordinate</u> the adaptive management monitoring, analysis, and reporting throughout the life of the project. RECOVER will include expertise from multiple agencies and disciplines, such as, hydrologists, engineers, and water managers; in other words, while RECOVER will be the central organizing entity of the adaptive management monitoring, analysis, reporting, and elevating of options to adjust CEPP, RECOVER will continually coordinate with others to ensure that a full suite of experts is included. CEPP project funds during pre-construction engineering and design (PED), construction, and operations and maintenance will support RECOVER's coordination efforts and the adaptive management strategies described in this CEPP Adaptive Management Plan. CEPP funds will be used to fund monitoring directly related to CEPP adaptive management monitoring needs and the funds are not designed to replace RECOVER's system-wide monitoring and science efforts. However, the RECOVER system-wide monitoring information will be used in combination with CEPP's monitoring to best address key questions about achieving restoration success. The intent is to have complementary efforts that maximize efficiency of monitoring. RECOVER will be responsible for ensuring that the adaptive management and monitoring plans are implemented and that the information is appropriately managed and integrated into the CERP decision process as outlined in the Adaptive Management Integration Guide (RECOVER 2011b).

Because of the fast track of the CEPP planning process it will be particularly important that RECOVER include scientists, engineers, and water managers in refinement of the monitoring and adaptive management plans during the project design, construction, and operations phases of the CEPP project. This section identifies which adaptive management activities will occur during these phases of CEPP project implementation and how they relate back to the project's adaptive management plan. Unless otherwise noted RECOVER will be engaged in all activities. Adaptive management will be reiterated in the coming phases of CEPP, and the Adaptive Management Plan will be reviewed and updated. At such time, more baseline data and lessons learned will be available from other monitoring programs and restoration projects. Given the new knowledge, key questions, monitoring thresholds/triggers, and adaptive management options proposed in this Plan may need refinement. Therefore, items included in this plan are not guaranteed to be included or funded as-is, but will be refined and considered again prior to CEPP implementation.

Adaptive management was incorporated during CEPP's planning with adaptive management experts integrally involved throughout the planning process. All of the items in the CERP "Project Level Adaptive Management Checklist" were considered and/or incorporated during the planning of CEPP, with the following exceptions: a conceptual ecological model (CEM) was not used in the Everglades Agricultural Area to develop hypotheses, since an approved model does not exist; scientific and local knowledge was used in lieu of developing a model for this area. CEMs were used for the other project areas including Lake Okeechobee, Northern Estuaries, Greater Everglades, Southern Coastal Systems, and the Total System (http://www.evergladesplan.org/pm/recover/cems.aspx). A cost effectiveness/incremental cost analysis of the future adaptive management options was not conducted due to time constraints during planning. Adaptive management activities on the checklist that will take place during and after the project's implementation are described here in the adaptive management Plan (CERP adaptive management checklist: http://www.evergladesplan.org/pm/pm_docs/adaptive_mgmt/062811_am_guide_final.pdf). The following subsections identify how adaptive management has been and will be incorporated into each CEPP project phase: planning, design, construction, and operations and maintenance.

1.5.5 How Adaptive Management Activities were Applied during CEPP Planning

The checklist of adaptive management activities (RECOVER 2011b) focuses on gathering sound information to develop a project's goals, objectives, and vision; involving agencies and stakeholders; identifying concerns and uncertainties; coordinating with interagency science groups during planning; addressing uncertainties as possible with robust and flexible project design; and identifying key uncertainties, monitoring, and management options that relate to the key uncertainties in order to systematically gather information to address them. Highlights of CEPPs incorporation of these adaptive management principals include the use of extensive scientific knowledge and modeling during all steps of the study. CEPP also had a robust interagency and public participation process throughout the study. Concerns and uncertainties were identified in an initial step for CEPP, discussed throughout the USACE "In Progress Review" meetings, and discussed throughout the interagency and public participation process. During screening of management measures to develop alternative plans, screening criteria included flexibility (the speed, ease, efficiency that a management measure could move water to adjust to changing real-time conditions such as storms or extreme events), robustness (the ability to function effectively in the face of broad-scale, uncertain future conditions such as climate change [NRC 2007]), and future compatibility (the efficiency with which this management measure or configuration would compliment future restoration work). Finally, a broadly invited interagency team developed the adaptive management plan to prioritize the remaining uncertainties and describe in the plan how they may be addressed through the life of CEPP and inform CERP implementation.

Overall, the inclusion of adaptive management principals during this study provided several avenues to address and reduce risks and uncertainties and, during its continued implementation in the following phases of CEPP, will provide a mechanism to continue CEPP's achievement of its vision, goals, and objectives and effectively remain within its constraints.

1.5.6 How Adaptive Management Activities Will be applied during CEPP Implementation

1.5.6.1 Project Management

RECOVER will work with the CEPP project managers to develop workplans and monitoring scopes of work in coordination with other technical resource providers as needed to provide the budget, schedule, and details to execute the adaptive management strategies identified in the Annex D. At a minimum, one RECOVER scientist should be dedicated to overall all coordination of the CEPP monitoring and adaptive management efforts. Additional technical expertise should be engaged as needed. adaptive management activities will be implemented in sequence with the project components being implemented (see **Table D.1-6**). Workplans will include all necessary activities, resources needed, and schedule for completion so that they can be resourced appropriately and tracked by the project manager for progress and execution as part of the project schedule and implementation plan during design, construction, and operations.

Project components will be implemented in a staggered fashion due to budget (amount of funds available each year), regulatory requirements (permits and compliance monitoring feedback), and CEPP dependency constraints (state and federal projects required prior to implementation of a specific CEPP project component). Time needed to conduct certain adaptive management activities and tasks to inform subsequent project component is incorporated in the CEPP implementation schedule and the Strategies section of the CEPP adaptive management Plan. Each adaptive management strategy workplan will explain the timing needed to observe, understand, and report restoration performance results from any design tests, pilot projects, and/or response to phases of project components or full project components being implemented to inform CEPP implementation (see **Figure D.1.10** for adaptive management strategies and project implementation diagram).

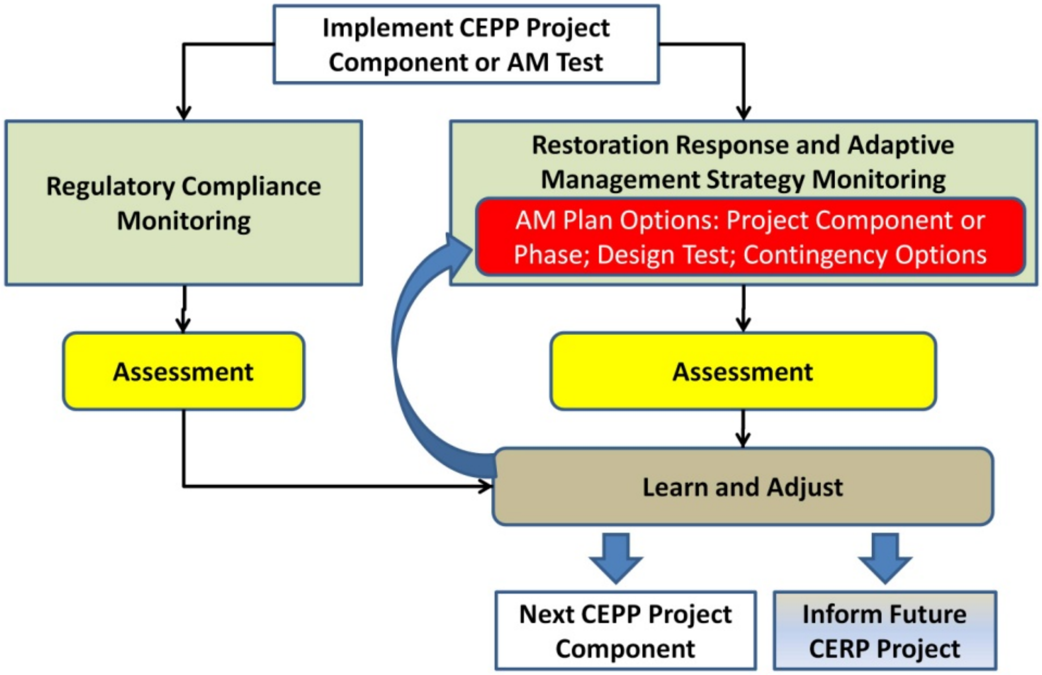


Figure D.1.10: Adaptive Management Strategies and Project Implementation Diagram shows that a CEPP project component may be implemented as a full project component, phase, or test.
Monitoring should be implemented before and after implementation for regulatory compliance, restoration response, and adaptive management purposes, as described in the adaptive management and monitoring plans. The monitoring data assessed after construction and new information can then be coordinated with CERP implementing and partner agencies to determine progress or the need for adjustments. Adjustments are implemented as part of the CEPP adaptive management strategies or made to the next set of CEPP project components. The information can also be used to inform future CERP projects.

Adaptive management during CEPP's staggered implementation will incorporate learning to reduce uncertainties and associated risk with some of the components, with the intent of achieving cost savings and providing the ability for certain project components to be implemented more efficiently. In order for this learning to occur, adaptive management strategies will need to be implemented in sequence with the project schedule (see Figure D.1.11: CEPP Project Component Schedule and Adaptive Management Implementation).

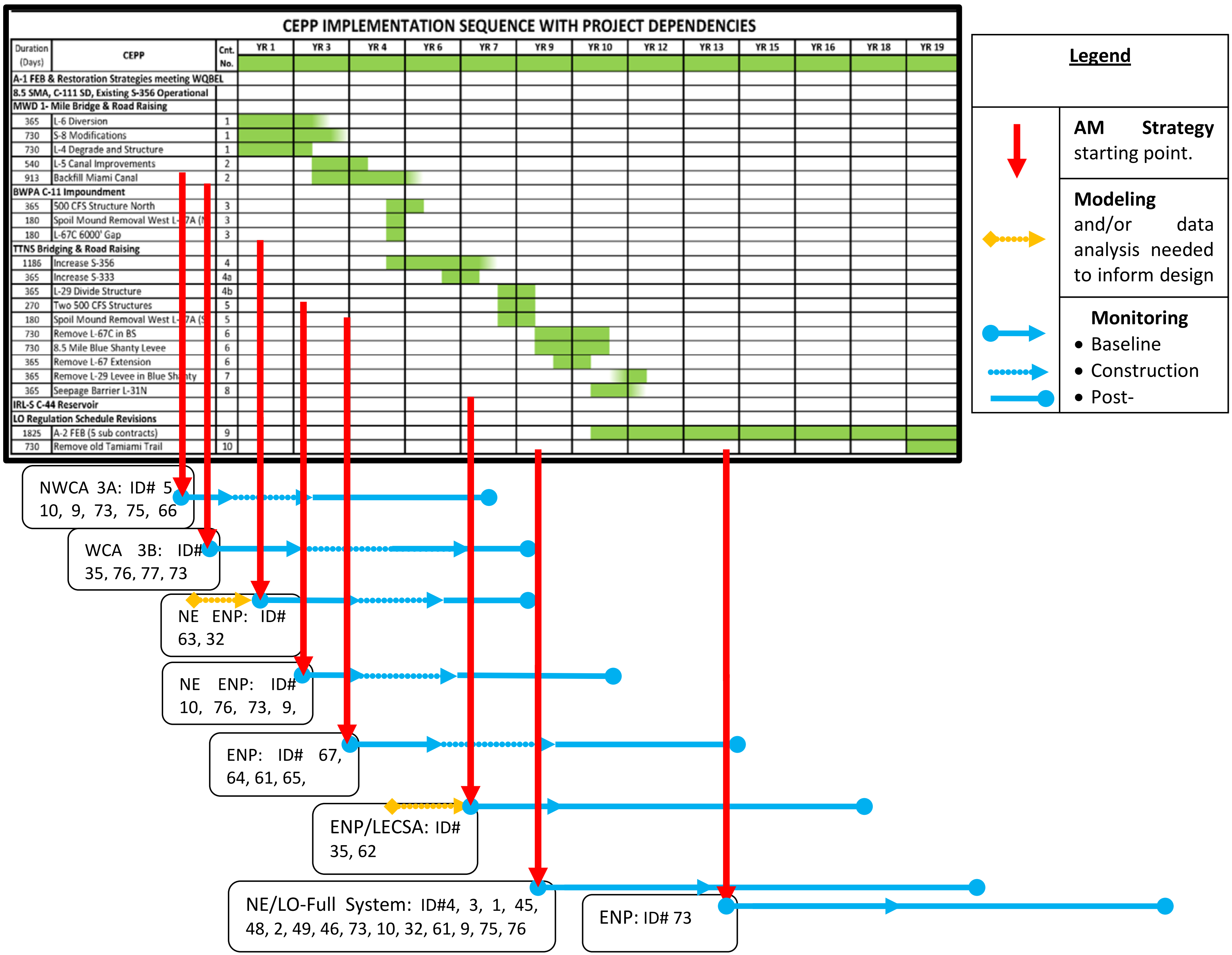

CEPP IMPLEMENTATION SEQUENCE WITH PROJECT DEPENDENCIES
Duration (Days)
CEPP
Cnt. No.
YR 1
YR 3
YR 4
YR 6
YR 7
YR 9
YR 10
YR 12
YR 13
YR 15
YR 16
YR 18
YR 19
A-1 FEB & Restoration Strategies meeting WQBEL
8.5 SMA, C-111 SD, Existing S-356 Operational
MWD 1- Mile Bridge & Road Raising
365 L-6 Diversion 1
730 S-8 Modifications 1
730 L-4 Degrade and Structure 1
540 L-5 Canal Improvements 2
913 Backfill Miami Canal 2
BWPA C-11 Impoundment
365 500 CFS Structure North 3
180 Spoil Mound Removal West L-67A 3
180 L-67C 6000' Gap 3
TTNS Bridging & Road Raising
1186 Increase S-356 4
365 Increase S-333 4a
365 L-29 Divide Structure 4b
270 Two 500 CFS Structures 5
180 Spoil Mound Removal West L-67A 5
730 Remove L-67C in BS 6
730 8.5 Mile Blue Shanty Levee 6
365 Remove L-67 Extension 6
365 Remove L-29 Levee in Blue Shanty 7
365 Seepage Barrier L-31N 8
IRL-S C-44 Reservoir
LO Regulation Schedule Revisions
1825 A-2 FEB (5 sub contracts) 9
730 Remove old Tamiami Trail 10
Legend
AM Strategy starting point.
Modeling and/or data analysis needed to inform design
Monitoring
• Baseline
• Construction
• Post-
NWCA 3A: ID# 5 10, 9, 73, 75, 66
WCA 3B: ID# 35, 76, 77, 73
NE ENP: ID# 63, 32
NE ENP: ID# 10, 76, 73, 9,
ENP: ID# 67, 64, 61, 65,
ENP/LECSA: ID# 35, 62
NE/LO-Full System: ID#4, 3, 1, 45, 48, 2, 49, 46, 73, 10, 32, 61, 9, 75, 76
ENP: ID# 73

Figure D.1.11: CEPP Project Component Schedule and Adaptive Management Implementation.

The following conceptual figure integrates the CEPP adaptive management Plan with CEPP project component implementation by showing the CEPP project construction sequence linked to CEPP adaptive management strategy number and monitoring duration. The adaptive management strategy ID numbers reference CEPP Adaptive Management Plan Section 5, which explains the adaptive management activities to be implemented.

Table D.1.10: CEPP Adaptive Management Strategy Implementation with CEPP Project Construction in NWCA 3A.

This table is associated with the following map (Figure D.1.12), and adds to Figure D.1.11 (above) by identifying CEPP project components (□ Drivers – Water management and restoration drive ecological change by changing stressor frequency, duration, and magnitude) and adaptive management strategies by area. This table specifies performance objectives and constraints to be avoided/minimized with each set of project components and the associated adaptive management strategies. Certain strategies involve sequential implementation of CEPP project components, e.g., ID# 73 regarding flow velocity for ridge and slough and the potential need for vegetation management to facilitate slough restoration. CEPP restoration performance expectations below are organized in a way that aligns with CERP conceptual ecological models: by stressors (o – Stressors are the factors most responsible for altering the Everglades ecosystem, such as altered hydrology; loss of habitat spatial extent and connectivity; altered geomorphology and topography), ecological effects (◊ - Ecological effects are the "cause-and-effect" linkages between stressors and ecological attributes), and attributes (⇔ Attributes –a minimum set of key ecological indicators to track the decline or improvement of desired restoration changes) following the symbology used in the South Florida Everglades Ecosystem conceptual ecological models (Ogden et al. 2005)

Region	CEPP Project Component	CEPP Restoration Performance Expectations	CEPP Adaptive Management Strategy
Northern WCA 3A	□ L-6 Diversion □ S-8 Modifications □ L-4 Degrade and Structure □ L-5 Canal Improvements	o Improved hydroperiods o Increased sheetflow ◊ Reduced fire risk and soil oxidation ◊ Peat accretion ⇔ Improve fish, alligator, wading bird conditions ⇔ Maintain sawgrass ⇔ Restore ridge and slough	ID# 5, 10, 9, 73, 75, 66, 59, 6
	□ Miami Canal Backfill	o Improve hydroperiods ◊ Reduced risk of muck fires and soil oxidation	ID# 5, 10, 9, 73, 75, 66, 59, 6

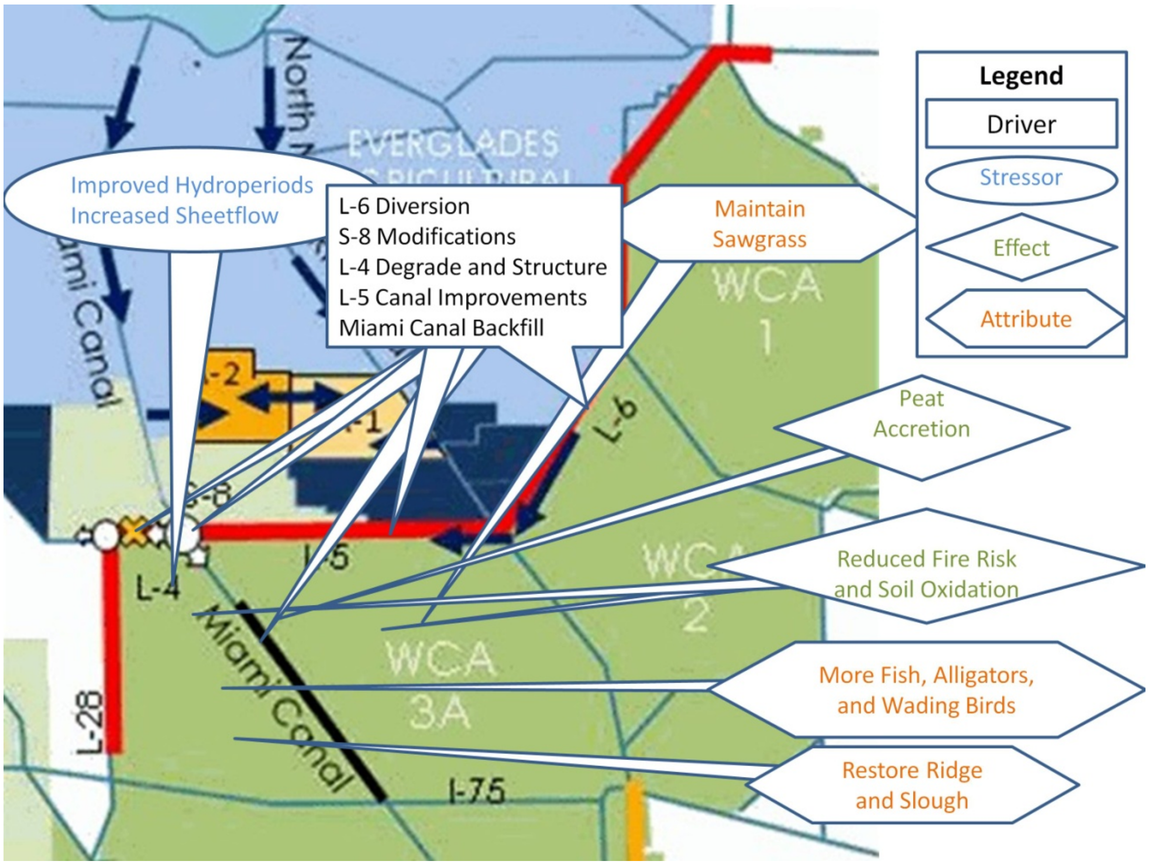


Figure D.1.12: Map of NWCA 3A Restoration Area, Associated Project Components, and Expected Performance.

Table D.1.11: CEPP Adaptive Management Strategy Implementation with CEPP Project Construction in WCA 3B. CEPP project components will be implemented incrementally in WCA 3B to test whether restoration performance objectives (hydroperiods, sheetflow, soil oxidation, fire, tree islands and ridge and slough) can be met minimum structures. This table and figure focus on restoration performance expectations east of the proposed Blue Shanty levee.

Region	CEPP Project Component	CEPP Restoration Performance Expectations	CEPP Adaptive Management Strategy
WCA 3B	□ Northern most L-67A conveyance structure □ 6,000-ft L-67C levee degrade	⬭ Improved hydroperiods ⬭ Improved sheetflow ◊ Reduced soil oxidation and fire ⇔ Maintain and restore tree island and ridge and slough	ID# 5, 35, 76, 77, 73
ENP	□ S-333 increase flows □ S-356 testing		ID# 5, 63

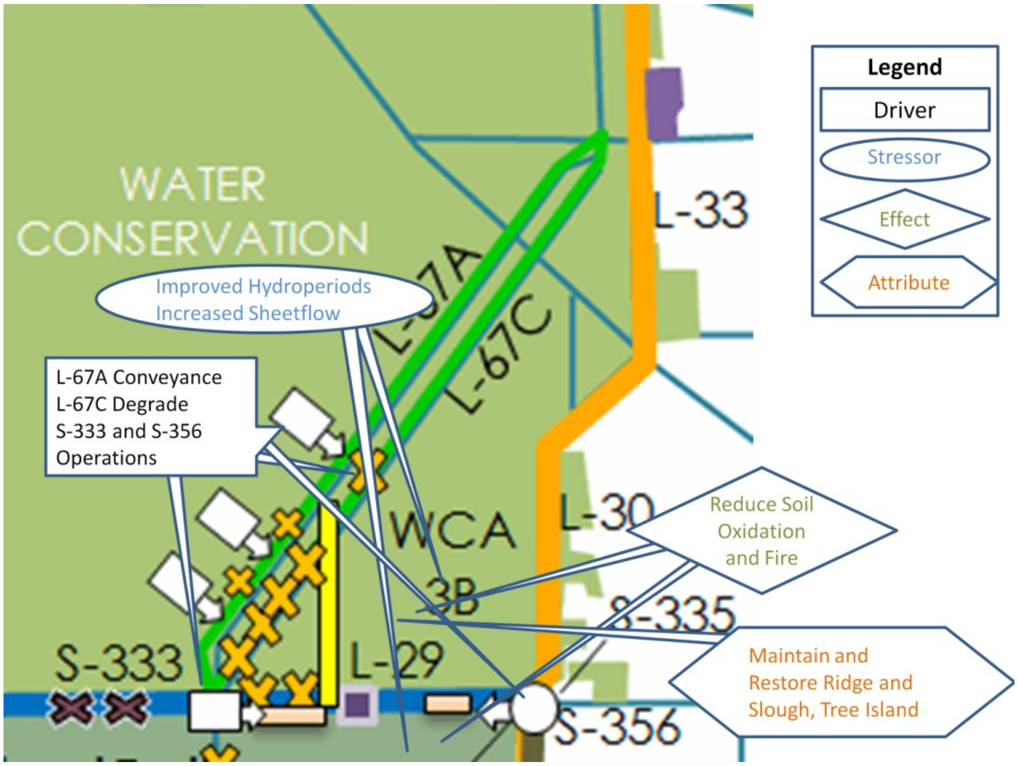


Figure D.1.13: Map of Restoration Area and Associated CEPP Project Components and Performance Expectations WCA 3B.

Table D.1.12: CEPP Adaptive Management Strategy Implementation with CEPP Project Construction in WCA 3B flowway and ENP.

The next CEPP project components will be implemented in WCA 3B and ENP to meet restoration performance expectations (hydroperiods, sheetflow, soil oxidation, fire, salinity in Florida Bay, tree islands and ridge and slough, small aquatic prey and wading birds, Florida Bay ecology).

Region	CEPP Project Component	Restoration Performance Objectives	Adaptive Management Strategy
WCA 3B, Flowway, and ENP	S-333 and S-356 improvements L-29 Divide Structure Additional L-67A conveyance Remove L-67C in Blue Shanty Flowway	Improved hydroperiods Improved sheetflow ◊ Reduced soil oxidation and fire ◊ Peat accretion ⇔ Tree islands and ridge and slough ⇔ Increase small aquatic prey and large predators	ID# 5, 10, 76, 73, 9, 75, 77
	Spoil Mound Removal West L-67A 8.5 Mile Blue Shanty Levee Remove L-29 Levee in Blue Shanty Flow Way	Improved hydroperiods Improved sheetflow ◊ Salinity and ecological improvements to Florida Bay ◊ Reduced soil oxidation and fire ⇔ Tree islands and Ridge and Slough ⇔ Increase small aquatic prey and large	ID# 5, 67, 64, 61, 65,

		predators	

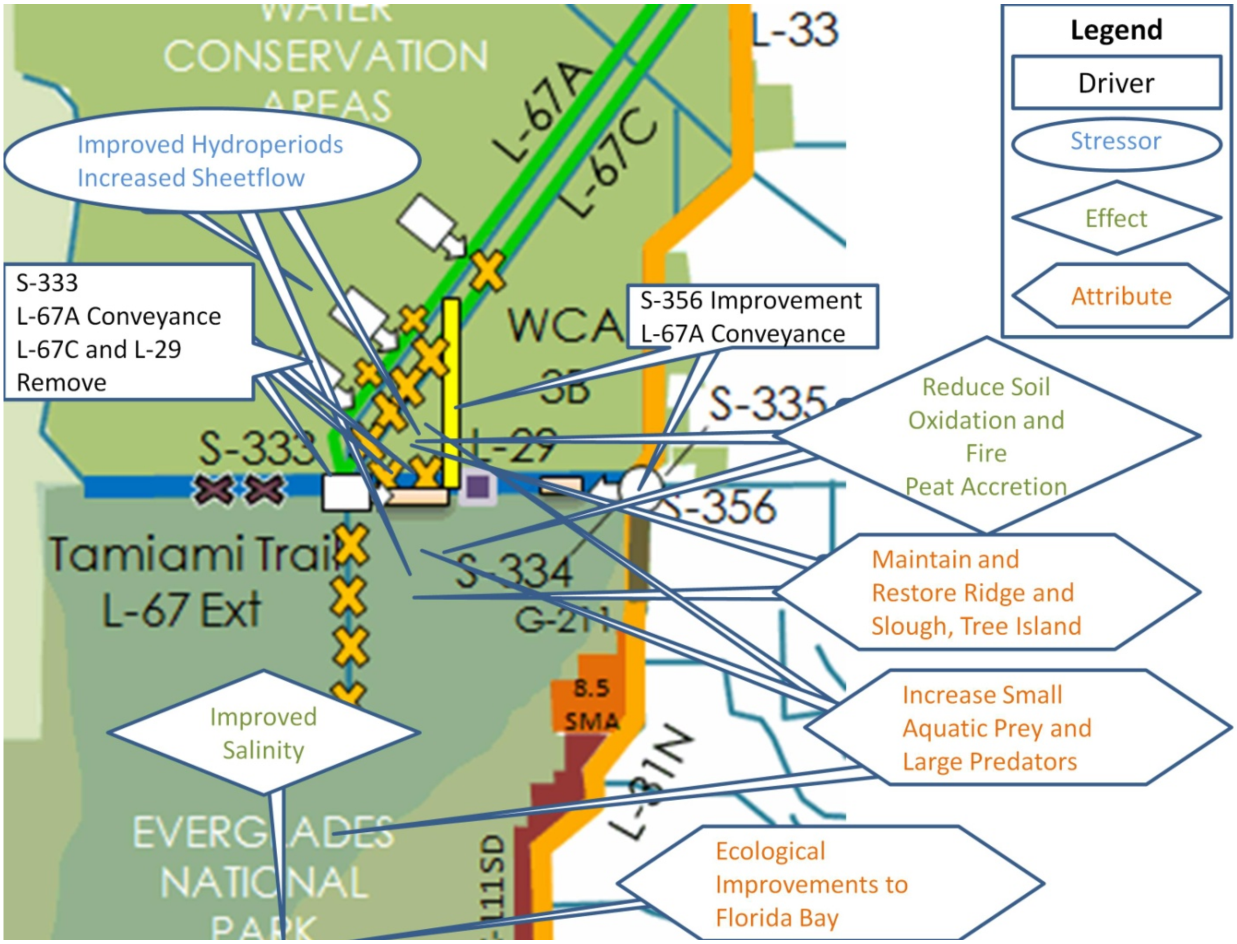


Figure D.1.14: Map of Restoration Area and Associated CEPP Project Components and Performance Expectations WCA 3B and ENP.

Table D.1.13: CEPP Adaptive Management Strategy Implementation with CEPP Project Construction in ENP, Miami-Dade, and Biscayne National Park (BNP).

Seepage management features will be implemented with adjustments to WCA 3 and South Dade Conveyance System operations to ensure restoration objectives in the Central Everglades are met, while not impacting current water supply, flooding risk, and Biscayne Bay salinity and ecology in BNP. Restoration performance expectations (hydroperiods, sheetflow, Lower East Coast (LEC) water supply, flood control, Biscayne Bay salinity, Biscayne Bay ecology) are to maintain current performance.

Region	**CEPP Project Component**	**Restoration Performance Objectives**	**Adaptive Management Strategy**
ENP-Miami-Dade – BNP	□ Seepage Barrier L-31 N Increment □ WCA 3 and South Dade Conveyance System Operations	⬬ Maintain flows in dry season ⬬ Maintain seepage control in wet season ◊ LEC water supply ◊ Flood control ◊ Biscayne Bay Salinity	ID# 35, 62, 77

		⇔ Biscayne Bay Ecology	

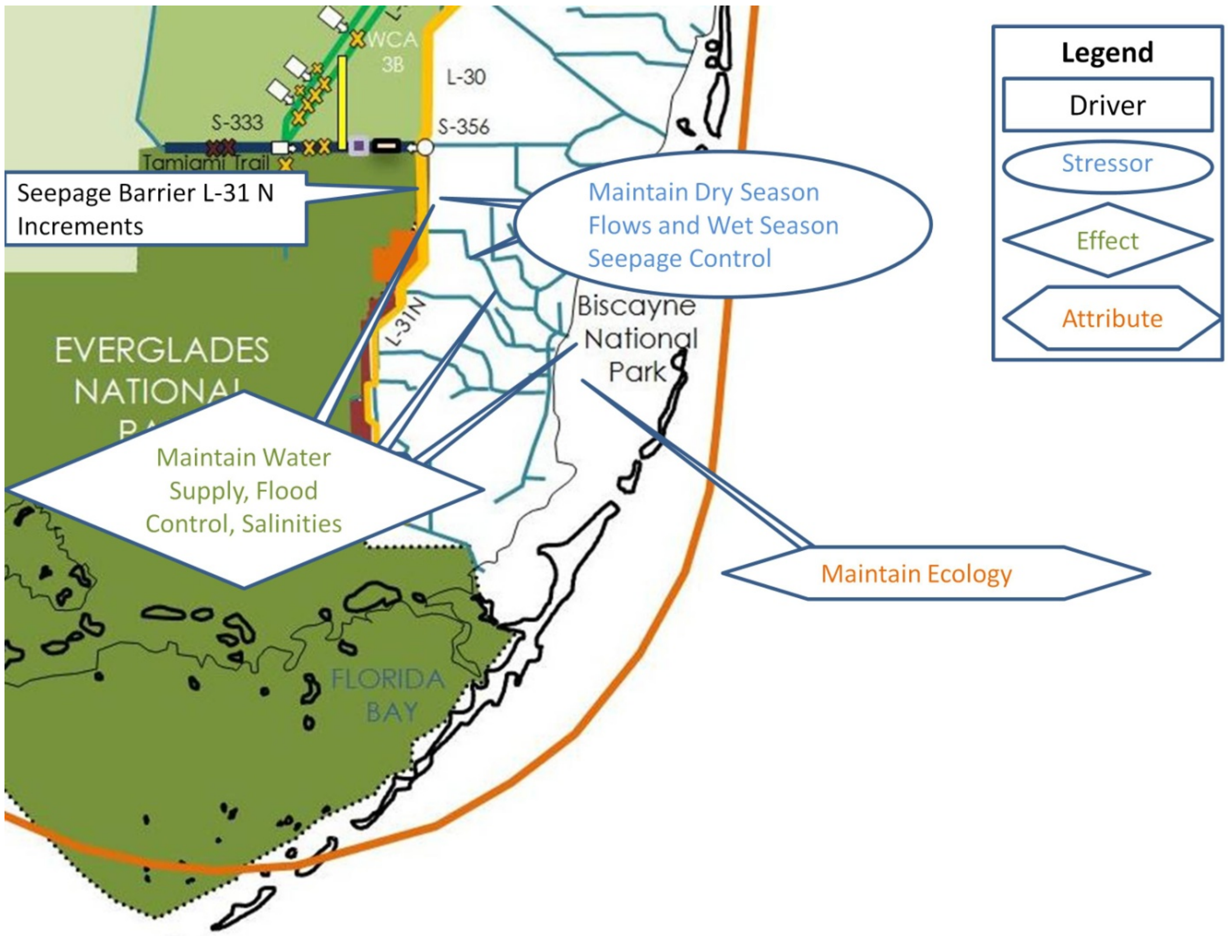


Figure D.1.15: Map of Restoration Area and Associated CEPP Project Components and Performance Expectations WCA 3B and ENP.

Table D.1.14: CEPP Adaptive Management Strategy Implementation with CEPP Project Construction and Operations Full System.

The next CEPP projects will be implemented: L-31 seepage management based on learning from seepage management testing, and A-2 FEB based on learning from A-1 FEB State Water Quality Strategies Science Plan to meet restoration performance objectives for the whole system. Stressors, effects, and attributes would continue to be observed for additional performance and avoidance/minimization of unintended effects. In addition, the restoration performance expectations in the Northern Estuaries (reduced high flows, improved salinities, increased oyster and seagrass density and acreage) can be met with implementation of these CEPP project components.

Region	CEPP Project Component	Restoration Performance Objectives	Adaptive Management Strategy
Full System	□ Seepage Barrier L-31 N Additional Increment □ A2-FEB	◊ ⇔ Full restoration benefits ◊ LEC water supply and flood control	ID#4, 3, 1, 2, 9, 10, 45, 49, 46, 61, 67, 73, 75, 76

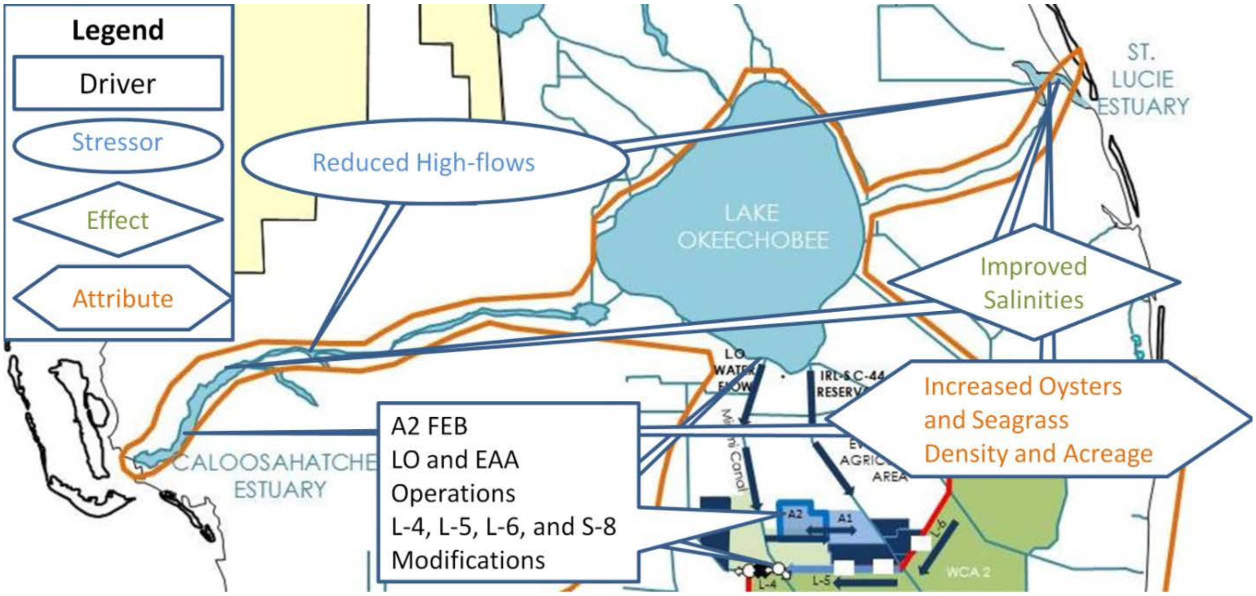


Figure D.1.16: Map of Restoration Area and Associated Project Components and Performance Objectives in Northern Estuaries.

Table D.1.15: CEPP Adaptive Management Strategy Implementation with CEPP Project Construction and Operations in ENP – Table describes remaining CEPP project components to construct if needed to improve sheetflow in ENP.

Region	**CEPP Project Component**	**Restoration Performance Objectives**	**Adaptive Management Strategy**
ENP	L-67 extension levee removal and modifications to old Tamiami Trail	Improved sheetflow	ID# 73

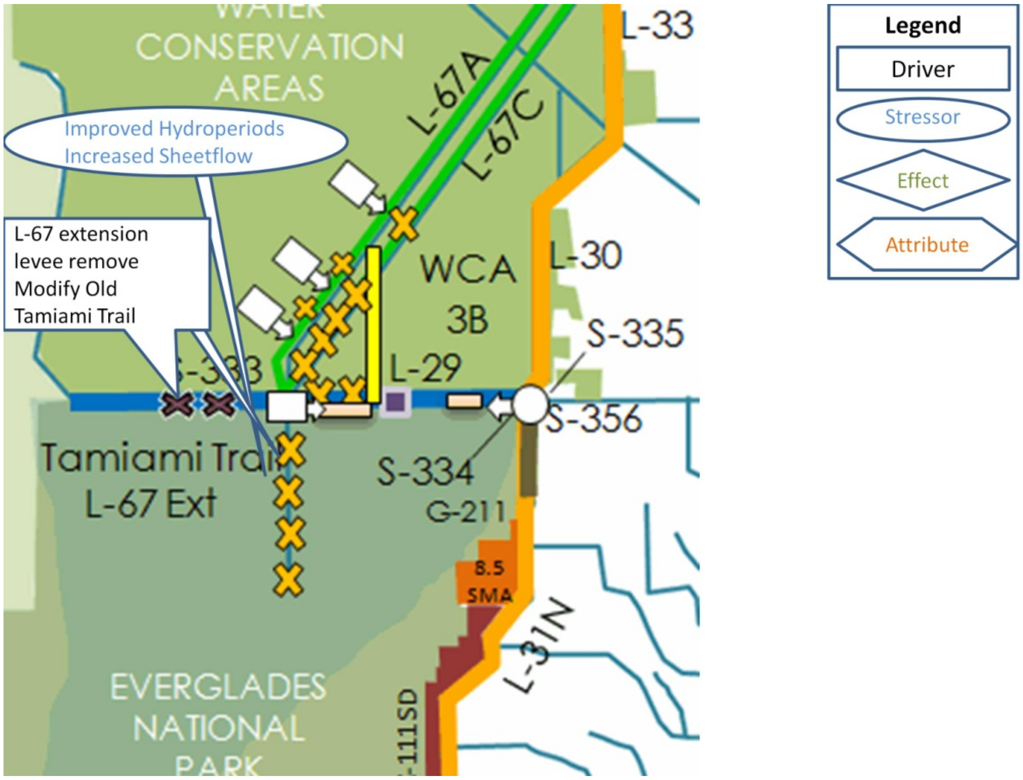


Figure D.1.17: Map of Restoration Area and Associated CEPP Project Components and Performance Expectations in ENP.

1.5.7 Design

Adaptive management activities will also be executed during the preliminary engineering and design (PED) phase of the project. Adaptive management strategies that may involve pilot projects, operational tests, and phased implementation as described in this adaptive management plan will be discussed during value engineering and detailed design to determine the full scope of each test, project construction phase and implementation. RECOVER team members tasked with overseeing CEPP adaptive management will coordinate with the CEPP engineers and water managers to ensure project designs, tests, and project operations manual allow flexibility for adaptive management implementation, as well as ensure monitoring plan designs, thresholds-triggers, and reporting is consistent with engineering design and water management needs. Adaptive management strategies will also involve updates to monitoring and assessment plans to better develop experimental designs, monitoring locations, and analysis methods, as well as initiate baseline monitoring data. Some adaptive management activities will need to begin early enough to allow development of the monitoring plan design and to implement monitoring contracts to support establishment of a minimal baseline before construction of CEPP project components is completed.

Monitoring and Experimental Design

RECOVER and other agency monitoring that is being relied upon to inform the CEPP implementation as identified in the adaptive management plan will be reviewed to determine if changes in scope and frequency are needed to better capture CEPP effects. The activities described here fall within the approved CEPP adaptive management budget. CEPP specific monitoring identified in the monitoring and adaptive management plan will require scopes of work, schedules, and assessment protocols to be developed and coordinated by RECOVER to determine monitoring location and experimental design details to update the monitoring plan. Data analysis and modeling may be needed to inform the statistical sampling design needed for monitoring to be able to test CEPP project hypotheses. Before and after control designs will be specified in the monitoring plan update, consistent with the parameters identified in each strategy and within the constraints specified by regulatory permits. CEPP monitoring plan design will use existing data where possible, e.g., RECOVER and other agency monitoring efforts. Adaptive management strategies maybe updated with more detailed decision trees to outline the decision-points associated with triggers/thresholds identified in each strategy. Decision trees will describe who receives reports, who provides guidance on decisions associated with the results, and what potential adjustments might occur. Updated monitoring plans will be coordinated for approval by implementing agencies and concurrence by participating agencies and Tribes.

Baseline Monitoring

In cases where there is not sufficient pre-project data monitoring, contracts will need to be initiated prior to construction of specific CEPP components (see **Figure D**.1.11 for illustration of baseline monitoring needs). Final assignment of agency monitoring responsibilities will be made after state and federal regulatory permits are issued for a component. RECOVER, USACE, and SFWMD monitoring points-of-contact will be identified to coordinate and implement monitoring with in-house agency resources or via contracts with CERP partner agencies and/or contracted universities or consultants to most efficiently and effectively execute the monitoring plan designs. Designated contacts will ensure that results are shared with the partnering agencies and non-governmental stakeholders for the duration of the monitoring plan. In addition, prior to construction of any component and/or test, a baseline monitoring report will be developed by RECOVER and coordinated with the project team and stakeholders, as stated in the PIR monitoring and adaptive management plan. The report results will be presented during annual (or as frequently as needed) State of the Central Everglades Planning Project technical meeting described below in the post construction and operations and maintenance section.

Pre-construction Engineering and Design (PED)

Project component designs will be developed and coordinated with RECOVER to ensure project component designs are consistent with the testing objectives identified in the adaptive management plan strategy. Further data analysis or review of other project design and monitoring information may be required to inform the design of CEPP project components (e.g., FEB and Seepage Management project components). In addition, monitoring locations that need to be installed prior to construction for baseline monitoring will be coordinated with the PED team to ensure they are aligned properly. The PED team will share project component plans and specifications with the RECOVER. Monitoring contract schedules will be aligned with project construction schedules and operating protocol as defined in the project component's operational strategy and consistent with the experimental design outlined in the adaptive management plan. RECOVER CEPP point of contacts will also be responsible for conveying results from annual monitoring reports to the PED team to help determine options for improving project designs, particularly for the blue shanty and seepage management features, but also for additional project components when deemed relevant and necessary.

Project Operating Manuals

Project operating manuals are developed during design by water managers in coordination with engineers, and hydrologists to specify the operating criteria for each structure. Water managers and engineers will coordinate with RECOVER to understand what hydrologic analysis is needed to inform operational criteria to be used as part of adaptive management tests. In addition, RECOVER will work with water managers, planners, and hydrologists to ensure flexibility is incorporated into the project operational plan to allow for potential needed adjustments in the future consistent with regulatory constraints and NEPA analysis. RECOVER will work with water managers to identify the monitoring information, triggers and process to be included in the project operating manual that will inform operational adjustments. Project operating manuals should also include the process by which operational changes will be assessed throughout the year to integrate with assessments of monitoring data and report the effects of operational decisions as part of the annual State of the Central Everglades meeting, and/or similar relevant discussions. Draft project operating manuals will be reviewed by the RECOVER CEPP points of contacts, as well as regulatory agencies, to coordinate with the adaptive management strategies outlined in the PIR monitoring and adaptive management plan and with regulatory permit requirements.

1.5.8 **Construction**

Construction schedules, construction contract language, and implementation progress will be coordinated with RECOVER to ensure that appropriate flexibility is included as needed to be effective in fulfilling the intent of the adaptive management plan. Schedules and implementation should include monitoring and operational tests consistent with the adaptive management strategies described in the adaptive management plan in order to learn from project component implementation. In some cases, when agreed to by the implementing agencies, adaptive management strategies may require adjustment to construction schedules to be able to learn from implementation of one phase to inform additional phases. This logic will reduce uncertainty and risk, could reduce cost, and will need to be incorporated into the construction schedule and contracting approaches to ensure this flexibility. See **Figure D.1.11**, CEPP Project Component and Adaptive Management Implementation, for specific adaptive management strategies that are intended to inform construction schedule. For more detail, see specific example provided in **Figure D.1.18** for how one CEPP adaptive management strategy informs the construction schedule.

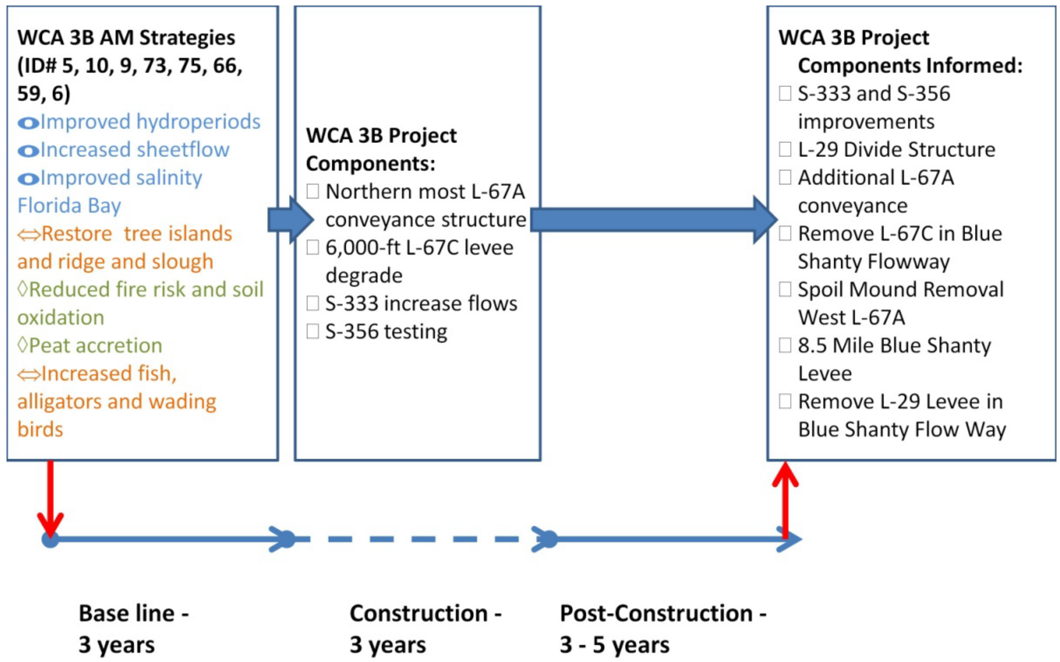


Figure D.1.18: CEPP Adaptive Management Strategy Informs Construction Schedule.
This figure identifies how the adaptive management strategies and monitoring timelines could inform the construction schedule to ensure opportunities to improve CEPP implementation. Adaptive management strategies (ID# 5, 10, 76, 73, 9, 75, 77) monitoring for WCA 3B should be implemented at least 3 years before all project components affecting the delivery of water into WCA 3B are constructed to establish a minimal baseline. (Please note that baseline monitoring will extrapolate backwards in time to create a longer baseline where possible, using RECOVER and other agency monitoring data). Minimal monitoring may occur during construction for 3 years. Between 3-5 years of post-construction monitoring is needed verify performance, and determine which CEPP project components to implement next in WCA 3B to achieve goals and objectives. In order to ensure WCA 3B projects are informed from lessons learned in WCA 3B, the design/construction of additional WCA 3B features would occur after the monitoring results are expected to be available. In this example, using the current TSP implementation schedule, the additional L-67 A structures could be modified during design, need for Blue Shanty substantiated, and the schedule lengthened by 3 -5 years before initiating construction for these features, if needed.

1.5.9 Post Construction and Operations, Maintenance, Repair, Replacement, and Rehabilitation

Post Construction Monitoring

CEPP specific project monitoring, RECOVER system-wide monitoring and other agency monitoring will be assessed by RECOVER to determine the restoration performance related to key project components or groups of components (see **Figure D.1.11** CEPP Adaptive Management Strategy Implementation and Project Construction). The timing outlined in each strategy will determine when data analysis and reporting should occur based on the temporal and spatial scale of the parameters being assessed. The triggers and thresholds outlined in the management option matrices and adaptive management strategies will guide the frequency of reporting and whom the reports are intended to inform. For example, strategies developed to address higher risk uncertainties may require more frequent reporting to CEPP implementing agencies and associated regulatory agencies to ensure constraints are addressed. Other strategies will have monitoring implemented after a particular project component is constructed for a specific timeline to report results to inform CEPP operations or construction of subsequent project components (See **Figure D.1.19**).

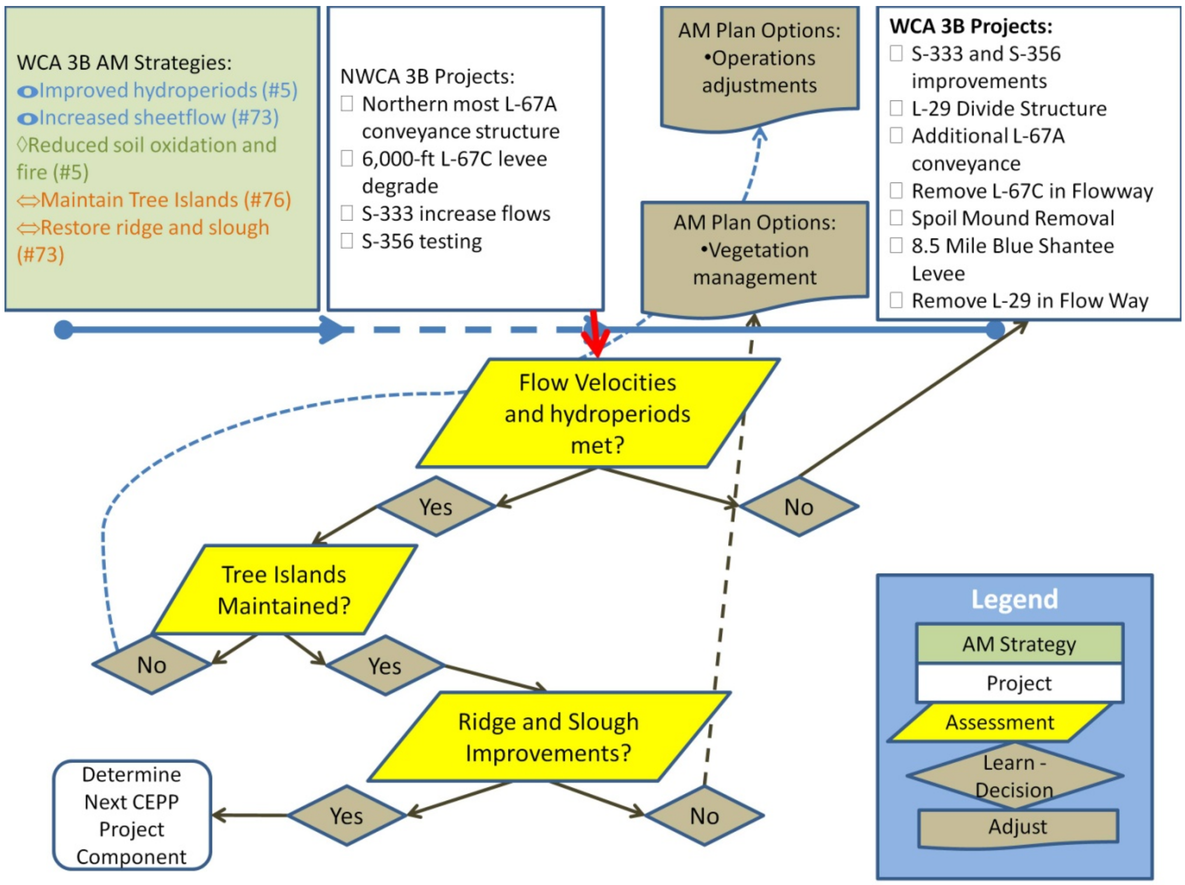


Figure D.1.19: CEPP Adaptive Management Strategies Inform Implementation.
Diagram of post-construction monitoring and adaptive management process, to compare with the during-implementation monitoring and adaptive management process illustrated in Figure D1X. In WCA 3B, post construction monitoring focuses first on whether flow velocities and hydroperiods being met. If not, analysis needs to determine why before determining the next set of CEPP project components to implement to improve performance. If yes, monitoring must substantiate tree islands are being maintained to avoid large unintended consequences. Monitoring is actually focused on both hydroperiods necessary for tree islands and tree island vegetation to determine if tree islands may be impacted. If tree islands are not being maintained (no), then operations need to be adjusted to minimize adverse affects on tree islands. If tree islands are being maintained (yes), then monitoring should examine the ecological effects and attributes indicating whether ridge and slough is improving. If not, vegetation management may be needed to open up sloughs and reinforce ridges. If they are improving, then scientists, engineers, managers need to determine next CEPP project components to implement, because original plan for additional L-67 conveyance and Blue Shanty Levee would not be needed.

Post Construction Assessment, Reporting, and Linking to Decision-Making

CEPP assessment results will be reported to the implementing agencies and CEPP partner agencies as part of the RECOVER system-status report, South Florida Environmental report, or more frequently if needed. The process for reporting results to decision-makers is provided in the CERP science feedback to decision-making diagram in the CERP Adaptive Management Integration Guide (Figure 3-9, RECOVER

2011b). The process has changed slightly since publication: 1) Senior-level decision-making/coordination bodies have been renamed from the Joint Project Review Board (JRB) to the Quarterly Executive Team (QET), and the Quality Review Board (QRB) to the Quarterly Agency Team (QAT.

As part of assessing and reporting CEPP's performance, annual State of the Central Everglades (CEPP) meetings will be coordinated by RECOVER to discuss assessment results. Scientists, hydrologists, engineers and water managers will present results of structural and operational changes (Drivers) and corresponding hydrological (Stressors), ecosystem processes (Effects), and ecological response (Attributes) specific to CEPP implemented project features, tests, and/or operational changes. The meeting goal will be to understand status and trends and potential causes of performance issues and/or success, as well as discuss the reality of what options (CEPP and non-CEPP related) are available to improve performance if needed. The meetings could occur in late summer or early fall after completing a water year (ending April 30). The meetings will be CEPP performance focused. The meetings will require coordination among RECOVER entities overseeing monitoring (CEPP project funded, RECOVER, and non-agency funded), and trained facilitation is recommended to ensure the technical meeting fulfills the CEPP assessment reporting goals. RECOVER will work with the South Florida Ecosystem Restoration Task Force's Science Coordination Group to determine if that forum should host the technical meeting to encourage broader non-governmental stakeholder participation.

No later than 1 -2 months after the annual State of the Central Everglades meeting, an environmental coordination meeting will be held with managers to discuss with managers any performance issues and to communicate success. This meeting will also be used to agree on the appropriate forum to make decisions about options to adjust CEPP implementation and operations, if determined to be needed, e.g., DCT, QET, or QAT.

Monitoring results will be reported in the context of the triggers/thresholds identified in the adaptive management strategies, e.g. if performance remains within the triggers/thresholds that are provided to indicate need for adjustments, then the operations may continue or the next project component may be constructed based on the demonstrated results. Constraint triggers/thresholds that are "triggered" will be reported to CEPP implementing agencies and associated regulatory agencies with suggestions of management options to implement, as stated in the adaptive management plan management options matrices (MOMs), to be evaluated by the agencies to decide what action is needed. Results of multiple monitoring trends will be integrated as part of a multiple lines of evidence analysis (Burton, et al. 2002; RECOVER 2006) to inform the potential need for adjusting CEPP implementation or documenting success.

Suggested options to adjust CERP implementation fall into several categories, listed here by level of effort required to implement:

1. Operational Decisions: Operations decisions are weekly/monthly, but get reported and summarized and reported at annual meetings. Annual meetings also are a forum to discuss potential upcoming operations decisions (e.g. , wet vs. dry years going into El Nino or La Nina years);
2. NEPA Covered Options, No Modeling Needed: CEPP adaptive management plan options that are covered by NEPA and do not require additional modeling or analysis beyond what has been discussed by scientists and managers;

3. NEPA Covered Options, Requires Modeling: CEPP adaptive management plan options that are covered by NEPA but may require model runs to determine best option;
4. Not NEPA Covered: CEPP adaptive management options that have not yet undergone sufficient NEPA analysis and therefore require additional environmental review and public comment, and potentially additional modeling.
5. Not Included in CEPP adaptive management plan: In some cases, the monitoring results may indicate the need for an option not identified in the adaptive management plan or PIR/EIS. This may result in agency-approved temporary adjustment to CEPP implementation and operations to avoid the constraint while potential project adjustments are further scoped, analyzed, approved, and budgeted for implementation. If additional technical expertise is required in RECOVER, an ad-hoc team could be formed to identify performance issues and options in a post authorization change report or make suggestions for a future CERP project.

The USACE Jacksonville District in consultation with Federal and State resource agencies and the USACE South Atlantic Division (SAD) and the South Florida Water Management District will guide decisions on determining whether restoration success has been achieved or additional operational, structural, or other contingency options identified in the adaptive management plan MOMs need to be implemented.

1.6 CEPP Adaptive Management Plan Cost Estimate

Identification of the CEPP monitoring contained in Annex D was guided partly by two objectives. First, it must be complete from a CEPP perspective in that it must provide the monitoring required to address CEPP-specific needs. Second, it must be integrated with other Everglades monitoring to take advantage of existing monitoring efforts, knowledge, and information and thereby leverage dollars committed and spent elsewhere to avoid redundancies and insure cost-effectiveness. These two objectives guided development of the adaptive management plan, hydrometeorological monitoring plan, water quality monitoring plan, and the ecological monitoring plan. Where possible, CEPP will rely on existing monitoring resources such as physical instrumentation, stations, locations, servicing, and analysis efforts funded by RECOVER, CERP sponsors, and partner agencies. Therefore the monitoring described in the CEPP Adaptive Management and Monitoring plan is limited to the additional, marginal increase in monitoring resources and analysis efforts needed to address CEPP-specific questions. It is assumed that the monitoring programs will continue for at least the time needed by CEPP. The cost estimate for the adaptive management monitoring is $24, 350,000. In addition, an estimate of $16,500,000 is provided to cover several adaptive management options that may be implemented. A summary of Annex D costs per project phase is provided in the introduction to Annex D.

Table D.1.16: CEPP Adaptive Management Monitoring Shown with Other Monitoring Programs.
This table is summarized in the Venn diagram in Figure D.1.20 but provides more detail. *Note that CEPP monitoring costs here assume all monitoring will take place in one 10-year window. Therefore CEPP costs here are a 'worst case', whereas the actually monitoring schedule is expected to stretch over the CEPP implementation schedule as shown in Figure D.1.10 and would therefore cost less per year.

Region or Specific CEPP Area	Uncertainty	ID#	Attributes to be Monitored	RECOVER 1-Yr Cost	Other Agency 1-Yr Cost	CEPP 1-yr Cost*	Sampling Frequency	Notes
Lake Okeechobee	Lake O littoral and near shore vegetation: potential effects Lake stages with CEPP	#3	littoral and near shore vegetation coverage	$ -	$ 47,000	$ 23,500	Current monitoring ranges from daily (Lake stages) to 3x per year (veg transects)	Assumptions based on need for additional labor to due analysis pursuant to CEPP objectives/constraints. SFWMD already pays for monitoring.
Everglades Agricultural Area Flow Equalization Basin (FEB)-2	How can we most effectively learn from the FEB-1 to integrate FEB-1 and FEB-2, to optimize their operations to maximize flows to the Everglades via the FEBs while balancing the related needs of Lake Okeechobee and the northern Everglades?	#4	TBD, but are likely to include the quality and quantity of fresh water delivered into and out of the integrated FEB- A-1 and FEB-2 units, STA 2 and STA 3/4, water into WCA 3A and at state water quality (WQ) monitoring compliance locations.	$ -	$ -	$ 135,000	Weekly	Estimate is based on proportion of additional monitoring needed to address A2 FEB specific questions that will arise after learning from the State Water Quality Strategies Science Plan reports on the A1 FEB.
Northern Estuaries Region (NE) St. Lucie Estuary (SLE)	Do reductions of high volume fresh water discharges result in measurable increases in submerged aquatic vegetation (SAV) coverage in the St. Lucie estuary (SLE)?	1	SLE SAV	$ 45,000	$ -	$ 45,000	6 summer months, 1 winter	

Region or Specific CEPP Area	Uncertainty	ID#	Attributes to be Monitored	RECOVER 1-Yr Cost	Other Agency 1-Yr Cost	CEPP 1-yr Cost*	Sampling Frequency	Notes
NE SLE	Will the increased frequency of low flow exceedences and timing in the SLE have a detrimental impact on oyster communities by increasing levels of predation and disease during extreme dry times? (ID#48)	45,48	SLE Oysters	$ 100,000	$ -	$ 10,000	Monthly, accept live /dead counts 4x/year	
NE SLE	To what extent will the reduction in the frequency and magnitude of high flows to the SLE help reestablish historic oyster beds on the south fork SLE? (ID#45)	1,45, 48	SLE Oyster and SAV mapping	$ -	$ -	$ 15,000	$75,000 every 5 years	
NE SLE	To what extent will the reduction in the frequency and magnitude of high flows to the SLE stabilize conditions enough to improve benthic habitat in the south fork St. Lucie estuary? (ID#46)	46	SLE Benthos	$ 85,000	$ -	$ -	quarterly	
NE SLE	see above	1,45, 48,46	SLE Salinity stations	$ -	TBD	$ -	daily	SFWMD and County salinity stations
NE SLE	see above	1,45, 48,46	SLE WQ	$ -	$ 40,867	$ -	monthly	SFWMD and County WQ stations

Region or Specific CEPP Area	Uncertainty	ID#	Attributes to be Monitored	RECOVER 1-Yr Cost	Other Agency 1-Yr Cost	CEPP 1-yr Cost*	Sampling Frequency	Notes
NE Caloosahatchee River Estuary (CRE)	Will the reduction in low flow exceedences in the Caloosahatchee estuary help re-establish healthy Vallisneria beds in the upper Caloosahatchee estuary? (ID#49)	2,49	CRE SAV	$ 68,000	$ -	$ -	6 summer months, 1 winter	
NE CRE	Do reductions of high volume fresh water discharges result in measurable increases in SAV coverage and oyster acreage and health in the Caloosahatchee estuary? (ID#2)	2	CRE Oyster	$ 190,000	$ -	$ -	Monthly, accept live /dead counts 4x/year	
NE CRE	see above	1,49	CRE Oyster and SAV mapping	$ -	$ -	$ 25,000	$125,000 every 5 years	
	see above	1,49	CRE Salinity	$ -	TBD	$ -	daily	SFWMD and County salinity stations
	see above	1,49	CRE WQ	$ -	$ 20,433	$ -	monthly	monthly SFWMD
Greater Everglades (GE) Northeastern (NE) Water Conservation Area (WCA) 3A	Will CEPP reduce soil oxidation and peat fires in NE-WCA3A, WCA-3B and SRS?	5	Soil Moisture Content; Peat Accretion; Fire mapping; Community Structure; Radiometric Dating; Soil Decomposition; Weather; Hydrology	$ 30,000	$ -	$ 100,000	Monthly, Quarterly; 1 GRTS every year	NE-WCA3A; CEPP - Fire mapping; CEPP 3 N-S transects; 2 E-W transects; 6 General Randomized Tessalated Stratification (GRTS) (2 CEPP) panels; CEPP - Hydro/met stations.

Region or Specific CEPP Area	Uncertainty	ID#	Attributes to be Monitored	RECOVER 1-Yr Cost	Other Agency 1-Yr Cost	CEPP 1-yr Cost*	Sampling Frequency	Notes
GE WCA 3B	Will CEPP reduce soil oxidation and peat fires in NE-WCA3A, WCA-3B and SRS?	5	Soil Moisture Content; Peat Accretion; Fire mapping; Community Structure; Radiometric Dating; Soil Decomposition; Weather; Hydrology	$ 15,000	$ 20,000	$ 50,000	Monthly, Quarterly; 1 GRTS every yr	WCA3B: One N-S transect; One E-W transect; 4 GRTS panels (2 RECOVER).; Everglades Depth Estimation Network (EDEN) Hydro USGS
GE Shark River Slough (SRS)	Will CEPP reduce soil oxidation and peat fires in NE-WCA3A, WCA-3B and SRS?	5	Soil Moisture Content; Peat Accretion; Fire mapping; Community Structure; Radiometric Dating; Soil Decomposition; Weather; Hydrology	$ 30,000	$ 100,000	$ 100,000	Monthly, Quarterly; 2 GRTS every yr	SRS: Two N-S transect; Two E-W transect; 8 GRTS panels (6 REOCVER). Other, Long Term Ecological Research Institute (LTER), ENP, USGS, and SFWMD hydro-Met Stations)
GE NE WCA 3A	Will CEPP hydroperiods, depths and flow velocities reestablish ridge and slough landscapes, including tree islands? -- Will Biogeochemical response be altered by changes in the timing and distribution of CEPP hydrology?	63, 73 and 76	Tree Island Attributes (Peat Accretion, Soil Nutrients, Community Structure, GW flows); Ridge & Slough Attributes (Community Structure, Floc analysis, periphyton, sediment movement, flow velocities); Canal Attributes	$ -	$ 60,000	$ 250,000	Large flow events, monthly; annual	Northern WCA-3A - Other SFWMD and EDEN.
GE WCA 3B and Blue Shanty Flowway	Will CEPP hydroperiods, depths and flow velocities reestablish ridge and slough landscapes, including tree islands?-- Will Biogeochemical response be altered by changes in the timing and distribution of CEPP hydrology?	63, 73 and 76	Tree Island Attributes (Peat Accretion, Soil Nutrients, Community Structure, GW flows); Ridge & Slough Attributes (Community Structure, Floc analysis, periphyton, sediment movement, flow velocities)	$ 65,000	$ 50,000	$ 425,000	Large flow events, monthly; annual	WCA-3B vs. Blue Shanty Flowway; Other (EDEN-SFWMD); RECOVER (GRTS panel and tree islands)

Region or Specific CEPP Area	Uncertainty	ID#	Attributes to be Monitored	RECOVER 1-Yr Cost	Other Agency 1-Yr Cost	CEPP 1-yr Cost*	Sampling Frequency	Notes
GE SRS	Will CEPP hydroperiods, depths and flow velocities reestablish ridge and slough landscapes, including tree islands?	73 and 76	Tree Island Attributes (Peat Accretion, Soil Nutrients, Community Structure, GW flows); Ecotone analysis	$ 150,000	$ 20,000	$ 75,000	Large flow events, monthly; annual	Western vs. Eastern SRS (RECOVER GRTS Panel, Transects marl prairie, Tree island, and vegetation mapping)
GE Everglades National Park (ENP) (SRS, Taylor Slough, Mangrove wetland, nearshore Fl Bay & Whitewater Bay Marl Prairie)	Will Biogeochemical response be altered by changes in the timing and distribution of CEPP hydrology?	63	Tree islands, Creeks and Marsh: Soil dynamics, Periphyton, WQ, Vegetation Mapping, Nutrient outflow to estuaries,	$ 100,000	$ 150,000	$ 150,000	monthly; Annual	ENP - RECOVER Vegetation mapping, periphyton, GRTS; Other (EDEN, SFWMD, ENP, LTER)
GE ENP (SRS, Taylor Slough, Mangrove wetland, nearshore Fl Bay & Whitewater Bay)	Will CEPP mitigate saltwater intrusion effects on coastal wetland vegetation , soil, and nutrient retention or release?	64	Changes in saltwater intrusion extent, salinity, vegetation, soil nutrient and carbon dynamics; Resistivity; Shallow wells.	$ 20,000	$ 100,000	$ 175,000	seasonal, Annual	ENP (SRS, Taylor Slough, Mangrove wetland, nearshore Fl Bay & Whitewater Bay) RECOVER - GRTS Other (SFWMD, ENP, LTER)

Region or Specific CEPP Area	Uncertainty	ID#	Attributes to be Monitored	RECOVER 1-Yr Cost	Other Agency 1-Yr Cost	CEPP 1-yr Cost*	Sampling Frequency	Notes
GE ENP (Fl Bay & Whitewater Bay / SW coast estuaries)	Will CEPP improve flows to Florida Bay and the Lower Southwest coast resulting in more natural salinity patterns (magnitude, spatial distribution and timing) to support estuarine food webs (SAV, sportfish, prey, coastal wading birds, and crocodiles)?	67,65	Coastal wetland and nearshore food web analysis and modeling	$ 400,000	$ 100,000	$ 75,000	daily, seasonal, annual	ENP (Fl Bay & Whitewater Bay / SW coast estuaries) Other (SFWMD, ENP, LTER)
GE WCA 3A (NW, NE, South)	How much will hydrologic restoration and vegetation management in Northwest WCA 3A, WCA 3B and NESRS result in increases in prey densities (aquatic fauna).	75, 9	Aquatic fauna density; Large fish density		$ -	$ 50,000	Five times per year	WCA 3A (NW, NE, South)
GE WCA 3B	How much will hydrologic restoration and vegetation management in Northwest WCA 3A, WCA 3B and NESRS result in increases in prey densities (aquatic fauna).	75, 9	Aquatic fauna density; Large fish density	$ 500,000	$ -	$ 25,000	Five times per year	WCA 3B
GE SRS	How much will hydrologic restoration and vegetation management in Northwest WCA 3A, WCA 3B and NESRS	75, 9	Aquatic fauna density; Large fish density		$ -	$ 20,000	Five times per year	NESRS

Region or Specific CEPP Area	Uncertainty	ID#	Attributes to be Monitored	RECOVER 1-Yr Cost	Other Agency 1-Yr Cost	CEPP 1-yr Cost*	Sampling Frequency	Notes
	result in increases in prey densities (aquatic fauna).							
GE WCA 3A (NW, NE)	How much will CEPP improve terrestrial wildlife and alligator relative density and body condition in northern WCA 3A?	10	Alligator relative density; Alligator body condition; Deer abundance; Wildlife Diversity	$ -	$ -	$ 85,000	Twice a year (Spring and Fall)	CEPP (2 NW, 1 NE, 1 S routes)
GE WCA 3B	How much will CEPP improve alligator relative density and body condition in northern WCA 3A, WCA 3B and NESRS?	10	Alligator relative density; Alligator body condition	$ -	$ -	$ 15,000	Twice a year (Spring and Fall)	WCA 3B CEPP (1-2 routes)
GE SRS	How much will CEPP improve alligator relative density and body condition in northern WCA 3A, WCA 3B and NESRS?	10	Alligator relative density; Alligator body condition	$ -	$ -	$ 15,000	Twice a year (Spring and Fall)	NESRS(1-2 routes)
GE WCA-3B, Blue Shanty flowway, WCA 3A (NW, NE, South), SRS, Fl Bay	How much will hydrologic restoration and vegetation management result in increases in wading bird foraging conditions and increased nest number and success of Wood Storks and Roseate Spoonbills?	75	Prey availability, Integration/refinement of existing modeling tools/application after construction	$ 400,000	$ -	$ 120,000	One season (dry)	WCA-3B, Blue Shanty flowway, WCA 3A (NW, NE, South), SRS, Fl Bay

Region or Specific CEPP Area	Uncertainty	ID#	Attributes to be Monitored	RECOVER 1-Yr Cost	Other Agency 1-Yr Cost	CEPP 1-yr Cost*	Sampling Frequency	Notes
Lower East Coast (LEC) Uncertainties	Will the constructed and operational features of CEPP maintain flood protection level of service east of the L-30, L-31, and C-111 without reducing quantity or quality of groundwater in water supply wellfields compared to existing conditions? (ID#35 –);	35, 62	Hydrologic & WQ (Surface/GW; Salinity; Stage; Flow)	$ 110,000	$ 1,551,000	$ 225,000	Monthly; Continuous	Salinity - 38k@; 27 SWL-MC; 9 CG; expand 5 up SRS to existing gages (I have an exact estimate somewhere in my files, need more time to find it); drill 3 new GW wells to the east towards Model Lands; total ; 15K 1 time install to existing gage/well; 100k to drill new GW well; surface water $15K @. 15 stations in creeks/wetlands, 10 in estuary, 20 in LEC canals, 20 in LEC GW.USGS, NPS, SFWMD, Miami-Dade, RECOVER, Rock Miners
LEC Uncertainties	Will the constructed and operational features of CEPP reduce surface and/or groundwater base flows and wetland/groundwater recharge to the east of the L-30 and L-31N in areas such as the Pennsuco Wetlands, south Miami-Dade wetlands, and Biscayne Bay? (ID#62)	35, 62	Ecological (Seagrass; Spoonbills; Fish; Vegetation)	$ 316,000	$ 150,000	$ 175,000	Quarterly, Annual	spoon bill - Jerry FY11 RECOVER and C-111SC (150k); vegetation Estimate based on Ross Marl Prairie transect @ 125k FY11; fish - 450k for Serafy 2x year + Kelble annual

Region or Specific CEPP Area	Uncertainty	ID#	Attributes to be Monitored	RECOVER 1-Yr Cost	Other Agency 1-Yr Cost	CEPP 1-yr Cost*	Sampling Frequency	Notes
CEPP-wide Invasives and Nuisance Species Management Plan (INSMP)	How will CEPP influence the introduction and growth of non-native invasive and native nuisance species populations within the project area, and will the species influence the predicted landscape and performance of CEPP?	59	See INSMP	$ -	$ -	$ -	Daily, Monthly, Bi-annually	See INSMP
			CEPP subtotal per year	**$ 2,624,000**	**$ 2,409,300**	**$ 2,437,500**	**CEPP Total**	**$24,375,000**

1.7 CEPP Screened Uncertainties

1.7.10 Uncertainties Screened Out of CEPP Adaptive Management Plan

The following **Table D.1.17** lists the uncertainties screened out of the adaptive management plan. Reasons for screening out suggested uncertainties may have included lack of direct relevance to project object or constraint, low ratings in the screening criteria described earlier in this Plan, inappropriate scale for CEPP (system-wide scale questions may be more appropriate to include in the RECOVER System-wide Adaptive Management Plan; very small scale questions may have scored low in the screening criteria), lack of ability to improve CEPP performance by understanding more about the uncertainty, or simply that the uncertainty was already covered by another that had been suggested (duplicates). The suggested uncertainties are organized below by ID tracking number, geographic area, and brief CEPP adaptive management sub-team meeting notes on rationale for screening are included.

Table D.1.17: Uncertainties Screened Out of Adaptive Management Plan

Uncrty ID #	Region	Risk or question or uncertainty	Meeting notes and discussions	Rationale of uncertainty removal
1	Northern Estuaries	Do reductions of high volume fresh water discharges result in measureable oyster responses in the south fork of the ST. Lucie estuary (IRL)?	Operational uncertainty for this increment, will need to specify whether benefits come out as expected. Future increment of restoration may need to include muck removal.	Removed -Covered under Uncertainty #45 - To what extent will the slight reduction in the frequency and magnitude of high flows to the SLE help reestablish historic oyster beds on the South Fork?
2	Northern Estuaries	How much does CEPP reduce high flow events to the estuaries during the wet season? Does CEPP increase the ability of LO to make low flow releases during the dry season?		Removed -Uncertainty is covered under: # 45 (SLE oysters), 46 (SLE benthic), 49(CAL Vallisneria), 1 (SLE SAV), 2 (CAL SAV)

Uncrty ID #	Region	Risk or question or uncertainty	Meeting notes and discussions	Rationale of uncertainty removal
7	Northern 3A	It is anticipated that the current dominance of terrestrial and invasive vegetation (e.g., shrubs, willow and cattail), especially in the NW region, will transition to more aquatic wetland vegetation (e.g., sawgrass, water lily, spike rush), which could affect valued upland wildlife currently in this area (e.g., deer, raccoon, rabbits). What will be the rate of this transition and how will it impact terrestrial habitat and wildlife? How do we manage hydrology and vegetation to minimize losses of upland habitat across the most northern regions of WCA 3A so to minimize adverse impacts on terrestrial wildlife?	Not an uncertainty that needs testing.	Removed. Questions related to hydrologic restoration and vegetation management resulting in restoration goals covered under #6, and #75.
8	Northern 3A	Cattail and Willow expansion may be an issue and needs to be properly managed to avoid further degradation.	This is also discussed in the CEPP Invasive and Nuisance Species Management Plan.	Removed: Uncertainty covered under #75, and #9
11	Northern 3A	How can CEPP maintain the pre-drainage sawgrass plain community in the northeast while increasing hydroperiods to the west?	Covered under different uncertainty	Removed: Uncertainty covered under #6

Uncrty ID #	Region	Risk or question or uncertainty	Meeting notes and discussions	Rationale of uncertainty removal
12	Northern 3A	Uncertainties exist related to the effectiveness of the Miami Canal designs and habitat value of Tree Islands vs. Spoil Mounds, or, Are CEPP constructed tree islands a functional replacement for existing FWC vegetated mounds?	Lots of discussion on this, not sure if it will have transferable information once the work is complete. This is more of a design issue; will design and construct and probably not change. No experiment with this, but important to monitor that it functions as a tree island or not. Also scored low on Risk (i.e. important but would not cause CEPP to fail).	Make sure relevant scientists are involved in the detailed design of the planted Miami Canal mounds; design them to promote learning and gaining transferable information if possible.
13	Northern 3A	Will sheetflow be impeded with the current vegetated mounds or with the addition of CEPP planted mounds along backfilled Miami Canal, and how will they affect the unwanted drainage effect of the canal?	Discussed thoroughly by CEPP team and adaptive management team; not an uncertainty that would be tested. Don't think the mounds will impede desired flows, and they are aligned with historic ridges and sloughs. Confident that the mounds will block the canal flow.	Remove: real world experience with tree islands as part of ridge and slough landscape suggests tree islands will not inhibit sheet flow, but will inhibit unwanted canal flows.
14	Northern 3A	Will tree island plantings on mounds be as effective as non vegetated filled sections in promoting flow?	FWC may want to cover some of the questions as part of planting efforts.	Same comments as #13
15	Northern 3A	How will exotic fish respond to CEPP components?	If they do, what will we do? I.e. limited adaptive management opportunities. This will be addressed in CEPP invasive species plan. Also, partially covered in trophic web monitoring.	Ranked low in screening.
16	Northern 3A	Can ridge and sloughs be connected across the canal, after backfilling it?	Design of planted mounds partially addresses this.	Removed: essentially covered under uncertainty #73

Uncrty ID #	Region	Risk or question or uncertainty	Meeting notes and discussions	Rationale of uncertainty removal
6	Northern 3A	Will CEPP achieve simultaneous sawgrass/ridge-slough habitats in northern WCA 3A with the addition of fresh water through the western hydropattern restoration feature?		Included in CEPP ecological monitoring plan rather than adaptive management plan.
17	Central and Southern WCA 3A	To what extent will ponding be reduced by allowing for additional outflows from the south end of WCA 3A along Tamiami Trail and the L-67s, and by gapping the C-11 extension levee?	S12s would address ponding in southern 3A and that is not changing. Could shift more water through 333 and away from S12s (management action). This would be covered under regulatory monitoring.	This question is appropriate for monitoring, but is not an adaptive management uncertainty for testing.
18	Central and Southern WCA 3A	How well can sheetflow be enhanced by operations in the first CEPP increment (e.g., additional conveyance across Tamiami Trail and L-67s)?	Feeds back to velocities uncertainties. Duplicate. Needs to be worked on in operations plan.	Removed: Covered under uncertainty #73
19	Central and Southern WCA 3A	How does seepage control constrain sheetflow in 3A? Because more water will be moving through WCA 3, how will seepage concerns be handled, if Broward County Water Preserve Areas project is not constructed before CEPP?	Issue considered during CEPP planning. Don't think this can be controlled through adaptive management. Operational constraint.	Removed.
20	Central and Southern WCA 3A	If hydrology is expected to improve, how much improvement in ridge and slough habitat will CEPP increment 1 achieve? How will ridge and slough landscape respond including slough connectivity, micro-topography, and peat accretion? Will increased flow velocities be needed periodically to reestablish sloughs and	This is a repeat uncertainty, covered under others.	Removed: Covered under uncertainty #73

Uncrty ID #	Region	Risk or question or uncertainty	Meeting notes and discussions	Rationale of uncertainty removal
		start reforming ridges?		
21	Central and Southern WCA 3A		This one was always blank, kept only for tracking purposes.	
22	Central and Southern WCA 3A	How much does reduced ponding improve wading bird and snail kite habitat?	Do not think we are reducing ponding enough to expect difference.	Removed: Modeling did not indicate that ponding would be reduced
23	Central and Southern WCA 3A	Will cattail and *Lygodium* encroachment occur and how would it be best to manage it?	See CEPP Invasive and Nuisance Species Management Plan (INSMP)	Removed: covered under other uncertainties and in INSMP
24	WCA 3B	How will the project achieve sheetflow through 3B at hydroperiods that maintain tree islands?		Removed: covered under uncertainty #76
25	WCA 3B	How resilient are tree island communities to hydroperiod changes that result from hydrologic restoration? Which tree islands are likely to respond well, which tree islands might not? How should operations be improved to avoid tree island impacts, while trying to achieve restoration of flow?	Combined 24 and 25 into "if tree islands do not respond, what could the management response be?"	Removed: covered under uncertainty #76
26	WCA 3B	How will wading birds respond to hydrologic changes in WCA 3B?	Took snail kite, apple snail and wood stork not considered here because they will be covered under the BO. Remaining spp covered under #75.	Removed: covered under uncertainty #75

Uncrty ID #	Region	Risk or question or uncertainty	Meeting notes and discussions	Rationale of uncertainty removal
27	WCA 3B	How will ridge and slough landscape respond including slough connectivity, micro-topography, and peat accretion? Will increased flow velocities be needed periodically to reestablish sloughs and start reforming ridges?		Removed: covered under uncertainty #73
28	WCA 3B	WCA 3B has been rain-driven for a long time, which contains low nutrient input. How will new flows from the marsh through WCA 3A mix with higher nutrient water in the L-67 canal? How can operations balance water quality and water quantity through this part of the system?	Could choose to put certain structures in WCA 3B first and operate at certain times (recommendation provided to CEPP implementation subteam)	Covered under #77.
29	WCA 3B	There is a potential for cattail and *Lygodium* encroachment that may need to be managed. (Similar to 23)	See CEPP Invasive and Nuisance Species Management Plan (INSMP)	Removed: covered under other uncertainties and in INSMP
30	ENP	Will there be water quality effects to ENP? Nutrient processing/bio chemical processes and their effects will be an important consideration to understand the effect of significantly increasing the volumes of inflows to North East Shark River Slough.	Ecosystem development and how nutrients get redistributed are part of this. Management actions are hard for this uncertainty.	Removed: covered under Uncertainty 63.
31	ENP	How will changes in hydroperiod within marl prairies effect vegetation and species dependent upon those habitats.	CSSS covered in BO. ENP to keep track of vegetation. Not part of CEPP adaptive management plan.	Partially covered in BO. This item may be better as an ecological monitoring item.

Uncrty ID #	Region	Risk or question or uncertainty	Meeting notes and discussions	Rationale of uncertainty removal
32	ENP	In Northeast Shark River Slough, how can operations most effectively optimize hydroperiod and minimize dry-outs with the proposed infrastructure to best restore ridge and slough landscape, including tree islands? (Need better understanding of hydrology and landscape changes, including peat dynamics).		Merged uncertainty ID 5, 7, 76
33	ENP	Will the increased flows through Shark River Slough improve the salinity regime in Florida Bay and the Southwest Coast? To what extent will the salinity regime of Florida Bay and the Southwest Coast be restored/improved?		Removed: covered under uncertainty #67.
34	ENP	Will CEPP Improve nearshore habitat and prey availability (i.e. salinity, SAV, fish, spoonbill, crocs)?		Removed: Repeat of uncertainty # 63 and 53
37	EAA	How can CEPP address the water supply and flood protection CERP goals for the CERP EAA Reservoir Project since the footprint intended for the reservoir projects will be used for FEBs ?	The question is valid, but not one that can be addressed in CEPP AM Plan. CEPP AM Plan scope is limited to questions where scientific method can be used to resolve or reduce an uncertainty to improve project performance.	Removed: This is a plan formulation question and overall system-wide planning issue for CERP. In addition, CEPP will not impact water supply or flood risk management per WRDA 2000. This issue is covered under #35 and 62.
38	CEPP Overall	Will FEB water use, water treatment, phosphorus reduction, and maintenance be similar to that simulated in model world? What actions or projects can be	As worded, not a question that can be addressed through CEPP adaptive management. However the intent of this uncertainty will be covered in	Removed: covered under uncertainty #4.

Uncrty ID #	Region	Risk or question or uncertainty	Meeting notes and discussions	Rationale of uncertainty removal
		taken to minimize the chances that FEB performance will be problematic once a real FEB is constructed?	others that were not screened out.	
39	Miami-Dade	If a seepage management wall is part of the TSP, what actions, investigations, or projects can be undertaken to determine how best to construct a seepage management wall that will perform as simulated? Should there be more sensitivity simulations within this modeling effort to get an idea of what range of percentage seepage reduction achieves similar results in model world?	This is very similar (duplicate) to uncertainties #35 and 62, which are included in the CEPP AM Plan. Their AM strategies include pre-design investigations and focused modeling using updated data from several sources that should be available in coming months/years.	Removed: Covered better under uncertainty #35 and 62, which are included in the CEPP AM Plan.
40	CEPP Overall	What additional model runs, information and real world data will be developed to compensate for the areas in the CEPP modeling that are problematic? How can this be used in project development after a TSP is selected?		Removed: this question was brought up as part of of water supply/flood control savings clause and RECOVER analysis. Additional modeling was done to address PDT concerns (Alt4R and Alt 4R2) during formulation, while the uncertainties inherent in the modeling are recognized. Therefore remaining uncertainties #35 and 62 are included in the AM Plan and their strategies include focused modeling.
41	Miami-Dade County	What are the surface water and groundwater dynamics from ENP east and southeast across South Miami-Dade? How will containing more water within ENP impact adjacent lands on a seasonal basis?	This could be part of a strategy to address uncertainties #35 and 62.	Removed: covered to the extent possible under uncertainty #35 and 62.

Uncrty ID #	Region	Risk or question or uncertainty	Meeting notes and discussions	Rationale of uncertainty removal
42	CEPP Overall	If elements of the project performance depends on simulated operations different from current operations or the operations of features to be constructed; how can adaptive management be used to either support the implementation of new operations compatible with CEPP or respond to adjust project elements and performance when operations assumed in the CEPP TSP are not permitted?	Not an adaptive management uncertainty, modeling uncertainty (which is the same throughout all the uncertainties)	Removed: in general, the adaptive management plan will cover how operations will be informed and the operations plan will cover how the operations are adjusted.
43	Lake Okeechob ee	What data can be collected to determine that the operations proposed in CEPP to move water south to the FEBs has a neutral or beneficial impact on water availability from Lake Okeechobee for the Northern Estuaries and LOSA?	Not an uncertainty that can be tested, but partially covered under others in the CEPP plan.	Partially covered in Lake O, FEB-2, and northern estuaries uncertainties.
44	Lake Okeechob ee	Lake O will likely be kept deeper with the FEB in operation. An increase in lake stage may be ecologically problematic at times. How will additional unwanted water be removed from the lake if the FEB goes off-line unexpectedly for a substantial time period (e.g., due to embankment failures as has happened at other new facilities: e.g., Ten Mile Creek Reservoir, Grassy Island STA, Nubbin Slough STA, Lakeside Ranch STA)?	This is not a CEPP adaptive management question, add the information into the Ops plan that will be used for CEPP.	Removed: partially covered under uncertainty #3.
47	Northern Estuaries	Will the decreases in high flow events reduce the flow velocities enough to	Specific items to measure in relation to Uncertainty 1 and 2. Muck removal	Removed: Uncertainties # 1,2 cover the questions regarding freshwater discharge and SAV, which

Uncrty ID #	Region	Risk or question or uncertainty	Meeting notes and discussions	Rationale of uncertainty removal
		reduce the amount of suspended solids being introduced into the estuary?	would be used under SAV or oysters, so took this uncertainty out.	relates to both salinity and sediment.
48	Northern Estuaries	Will the increased frequency of low flow exceedences and timing in the SLE have a detrimental impact on oyster communities by increasing levels of predation and disease during extreme dry times?	Original North of the redline modeling revealed increased frequency of low flow exceedences to the SLE with the project alternative run.	Interagency Modeling Center modelers identified an error in the original modeling for basin flows, which were too low. In the modeling of the Alt4R2 TSP model, the low flow exceedences actually improved with the project alternatives. This is no longer seen as an issue that we are uncertain about that needs to be addressed.
50	Northern Estuaries	Will decreases in the velocity of flows be enough to reduce the current condition in which spat introduced into the water column during the wet season tend to get pushed far downstream where they settle and are then subject to increased salinities, predation and disease during the next dry season?	Specific items to measure in relation to Uncertainty 1 and 2. This fits under timing (need lower flows during specific times to not disrupt spat). Adding timing of flows to the oyster uncertainty.	Removed: covered for St. Lucie under # 45, focused on oysters for all life stages.
51	Lake Okeechobee	Further LO operational refinements under existing LO Regulation Schedule (LORS) 2008 might reduce duration and number of high volume discharge events. There may be questions on the effects on the littoral zone.	Lake O has a monitoring program; can we use this information?	Removed: Covered under uncertainty #3. Existing monitoring will be leveraged.

Uncrty ID #	Region	Risk or question or uncertainty	Meeting notes and discussions	Rationale of uncertainty removal
52	Lake Okeechobee	Lake O will likely be kept deeper with the FEB in operation. An increase in lake stage may be ecologically problematic at times. How will additional unwanted water be removed from the lake if the FEB or the new reservoirs (C-43, C-44) go off-line unexpectedly for a substantial time period (e.g., due to embankment failures as has happened at other new facilities: e.g., Ten Mile Creek Reservoir, Grassy Island STA, Nubbin Slough STA, Lakeside Ranch STA)?		Not a CEPP adaptive management Uncertainty that can be tested, but give this to Operations group as a comment to be addressed.
53	Southern Coastal Systems	Will the SCS be provided the water it needs for restoration from upstream (timing, distribution, quality and quantity)?	Broad question. Model results depict the amount of water the SCS will receive. This will be covered by the operation plan for CEPP and should be rewritten to include specific uncertainties for quantity, quality, timing, distribution as they relate to salinity and the Flora and fauna of the SCS. Not a CEPP adaptive management uncertainty to be tested as written.	Removed: covered by uncertainty #67
54	Southern Coastal Systems	How can we reasonably and accurately quantify the volume of water required for restoration of Bisc Bay, FL Bay and the SW Coast acknowledging real-world constraints?		Remove: covered under #67

Uncrty ID #	Region	Risk or question or uncertainty	Meeting notes and discussions	Rationale of uncertainty removal
55	Southern Coastal Systems	To what degree will sea level rise affect restoration efforts? Based upon how SLR will affect restoration efforts, what spatially sustainable areas should restoration afford a priority focus and how that priority determined?	Not entirely a CEPP-specific question. May be more appropriate for RECOVER system-wide adaptive management Plan or other large scale program.	CEPP-specific scale of this question covered under #64
56	Southern Coastal Systems	Getting water south requires meeting WQ standards. Will the additional water for restoration meet those standards, or will/can the standard be revised? Will the WQ standards be met in time to allow for waters to flow prior to a permanent loss in the already declining ecosystem characteristics?		Removed: partially covered under #63
58	Southern Coastal Systems	How will changes in funding affect implementation? How will delays in implementation due to funding constraints affect the final outcome (irreversible adverse changes)?	Budgetary uncertainty effects the whole implementation of this project, CERP, RECOVER monitoring. This is not a CEPP adaptive management question that can be tested.	Removed. Discussed in implementation section of CEPP PIR.
68	ENP	Ecol response in wetland food web - prey base, wading birds		Removed: not clearly worded, and addressed under uncertainty #65

Uncrty ID #	Region	Risk or question or uncertainty	Meeting notes and discussions	Rationale of uncertainty removal
69	LEC Water Supply	Will conveyance, seepage management, and/or operations alter quantity and quality of water reaching water supply wellfields and potable water wells, especially during the dry season or in dry/drought years? More specifically, will risk of saltwater intrusion be increased in coastal wellfields and private wells, will risk of surface water influence be increased, or will wellfield protection boundaries be affected?	Similar to other uncertainties, so consolidate for AM Plan. Need to clarify water quality question as nutrients or saltwater intrusion. Partially addressed in savings clause analysis. Need to coordinate with water supply and flood control team. Need right expertise on how to handle water supply questions and operations.	Removed: reworded and covered under uncertainty #35 and 62.
70	LEC flood risk managem ent	Will conveyance, seepage management, and/or operations reduce flood protection in agriculture and urban areas, especially at the end of the rainy season, or during wet years? Will seepage walls (if selected) retain water as predicted in models?		Consolidate with uncertainty #s 35 and 62.
71	Pennsuco, Bird Drive, South Miami-Dade Wetlands	Will conveyance, seepage management and/or operation affect water depth, hydroperiod in wetlands east of the L-30/31, especially in the dry season?	Savings Assurances. Seepage management experts will need to tell us level of uncertainty, how it could be monitored, and what we would adapt (operations, implementation) to address.	Removed: covered under uncertainty #35
72	Biscayne Bay and adjoining tidal	Will conveyance, seepage management and/or operation affect salinity patterns in coastal wetlands and nearshore tidal waters, especially during the dry season?		Removed: partially covered under uncertainty #35, and 62

Uncrty ID #	Region	Risk or question or uncertainty	Meeting notes and discussions	Rationale of uncertainty removal
	waters			
74		How will apple snails respond to CEPP hydrologic changes?	Can include operation indicators into the operations plan rather than using adaptive management. This will most likely be covered under the BO. No management options.	Removed: apple snails were not one of the key restoration objectives, but are covered under the biological opinion and will be tracked accordingly.

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PART 2. CEPP Water Quality Monitoring Plan

Water Quality Monitoring

for

Central Everglades Planning Project

(Approval date for

RECOVER

QAOT

EMCT)

____
Authoring Organization's Representative **Date**
(Monitoring plan coordinator)

____
Lead USACE Project Manager **Date**

____
Lead SFWMD Project Manager **Date**

____
Representative, Local Sponsor (Monitoring Organization) **Date**

____
Representative, Federal Sponsor (Monitoring Organization) **Date**

____
Project Quality Assurance Officer **Date**

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GLOSSARY/ACRONYMS

ADaPT – Automated Data Processing Tool software.

Assessment – to interpret responses in natural and/or human systems based on data acquired though monitoring activities.

BWRF – Biweekly if Recorded Flow – Sampling frequency to collect sample on bi-weekly basis if flow has occurred in the past week.

Constraint – a condition that is to be minimized or avoided in the plan formulation and selection process to ensure that the project component does not result in undesirable changes in the project area or downstream waters. Example: The component shall not cause or contribute to a violation of state water quality standards.

Data Qualifiers: a code that is added to data to serve as an indication of the quality of the data.

Data Quality Objectives (DQO) – a process that identifies the intended use of the data including the types of decisions that will be made based on the results. The analytes of interest, corresponding action levels, sampling design and quality control measures are also identified as well as data repositories into which the data will be entered, the mechanisms used to ensure that the data are accurately entered into a database and to verify that the data in the database are correct, and the level of data quality acceptable for this project.

EB – Equipment Blank, collected to monitor on-site sampling environment, sampling equipment decontamination, sample container cleaning, the suitability of sample preservatives and analyte-free water, sample transport and storage conditions and laboratory processes.

EM – Engineering Manual: USACE documents that provide guidance on various aspects of project design and implementation.

FB - Field Blank, collected to monitor on-site sampling environment, sample container cleaning, the suitability of sample preservatives and analyte-free water, sample transport and storage conditions and laboratory processes.

FCEB – Field Cleaned Equipment Blank, collected to monitor on-site sampling environment, sampling equipment decontamination in the field, sample container cleaning, the suitability of sample preservatives and analyte-free water, sample transport and storage conditions and laboratory processes.

FDEP – Florida Department of Environmental Protection

Local Sponsor – the agency responsible for matching the Federal funding available for a project. The South Florida Water Management District (SFWMD) is the local sponsor for the majority of CERP projects.

Matrix – refers to the material from which the sample is taken, such as surface water, ground water, pore water, sediment, soil or air.

MeHg – Methyl mercury, a highly toxic form of mercury which may be bioaccumulated along food chains.

Monitoring – all of the activities required to acquire, process, store, retrieve and analyze data used to assess the status of water resources. It includes data collection, data analysis, data validation, and data management.

Monitoring Data – data that are collected for the purpose of determining the effects of CERP projects at a given location.

Monitoring Plan – the plan to acquire additional meteorological, hydrologic, hydraulic, water quality or ecological data. It includes considerations of sampling location, frequency, method, parameters and duration. It is based on the elements identified in the development of data quality objectives for the project.

Objective – a measurable element of the goal(s) of a project or plan. Project objectives and constraints are identified in the Project Management Plan (PMP).

Permit Requirement – certain analytes are sampled, tested and results reported to state and/or federal agencies as a condition of a permit to build or operate a project.

PLMP – Project-Level Monitoring Plan

Project-level – A project has a defined scope, quality objectives, schedule, and cost. Project-level activities refer to those that are within the scope of a specific project.

QA – Quality Assurance: the system of management activities and quality control procedures implemented to produce and evaluate data according to pre-established data quality objectives.

QAOT – Quality Assurance Oversight Team, comprised of representatives from USACE, SFWMD, FDEP, and USEPA, ultimately responsible oversight of the implementation of the quality system for CERP.

QASR – Quality Assurance System Requirements, the CERP Quality manual that establishes minimum criteria for environmental data quality.

QC – Quality Control: The system of measurement activities used to document and control the quality of data so that it meets the needs of data users as specified by pre-established data quality objectives.

RACU – Remote Acquisition and Command Unit. A device used for data acquisition and remote system control.

RECOVER – REstoration COordination and VERification (RECOVER) is a process that evaluates and assesses CERP performance by linking scientific and technical information throughout the planning and implementation period to ensure that a system-wide perspective is maintained throughout the restoration program.

RECOVER AT - The RECOVER Assessment Team is a standing, interagency, interdisciplinary team of scientists and resource specialists who are responsible for achieving the five primary tasks of RECOVER: 1) create, refine and provide documentation for a set of conceptual ecological models for the total system and a set of attribute-based biological performance measures for the Comprehensive Plan; 3) design and review the system-wide monitoring and data management program needed to support the Comprehensive Plan; 4) use the information coming from the system-wide monitoring program to assess actual system responses as components of the Comprehensive Plan are implemented and produce an annual assessment report describing and interpreting these responses; and 5) coordinate all scientific peer reviews of RECOVER documents.

RS – Replicate samples defined as two additional samples collected in addition to the routine sample.

Sampling Frequency – how often samples are collected.

Sampling Methods – the methods used to collect samples in the field. The methods should be standard methods, methods based on a standard operating procedure, or a method that has been approved by the participating agencies.

SFWMD – South Florida Water Management District

THg – Total mercury

USACE – United States Army Corps of Engineers

USEPA – United States Environmental Protection Agency

WBS – Work Breakdown Structure: The WBS specifies a hierarchy of tasks and activities necessary to fulfill the objectives of the project. The WBS is structured in levels of work detail, beginning with the deliverable itself, and is then separated into identifiable work elements.

WRF – Weekly if Recorded Flow: Sampling frequency to collect a sample if flow has occurred in the past week.

Zone of Influence – the area over which a project alters or impacts the environment.

Additional terms and definitions for CERP can be found in CGM 13 – Acronyms and Glossary of Terms. http://www.cerpzone.org/documents/cgm/cgm_013.03.pdf

EXECUTIVE SUMMARY

The CEPP water quality monitoring plan presented here was developed by an interagency team from SFWMD, USACE, DOI, and FDEP. In developing this plan, the interagency team reviewed the ongoing monitoring efforts within the study area as of January 2013 to determine what additional monitoring would be likely required to demonstrate compliance with existing requirements as well as anticipated requirements. The Water Quality Monitoring sub-team also consulted with the Adaptive Management team to minimize duplication of effort across monitoring efforts. The monitoring stations are preliminarily identified in this plan since final designs have not been prepared for any of the project features. As such, this plan incorporates the best information available; however, as the project is designed and implemented, this plan will require revision. To accommodate imprecise information, a 20% contingency was incorporated into the monitoring plan cost estimate. The estimated first year cost of this monitoring is $613,200 with the five-year cost estimated to be $3,018,000 and the ten-year cost estimated at $5,976,000. Generally, CERP project monitoring is cost-shared for a period of 10-years after which monitoring is paid for by the SFWMD. Given that the construction of the project features will require more than 10-years, the duration of cost-shared monitoring will extend past 10-years for the entire project; however, each monitoring activity associated with individual project features will not be cost-shared for more than 10-years.

2.0 INTRODUCTION

This document serves as a reference for monitoring surface water quality for the Central Everglades Planning Project (CEPP). Monitoring will be conducted to evaluate the CEPP's performance with regard to restoration goals and regulatory requirements. Specifically, the project is intended to send additional environmental water supplies south from Lake Okeechobee to the Everglades Protection Area in order to restore the historic function of the remnant Everglades landscape. The additional water will restore the original hydrologic patterns within the Everglades freshwater wetlands, and improve the wetlands and salinity patterns in the nearshore region of the Bay. Improved salinity patterns will restore more estuarine habitat to Biscayne Bay.

The CEPP area of influence includes Lake Okeechobee, Caloosahatchee Estuary, St. Lucie Estuary, Everglades Agricultural Area, Water Conservation Areas, Everglades National Park and the southern estuaries. **Figure D.2.1** shows a map of the study area.

2.1 Project Description

The CEPP project features include the following elements:

1. Storage and Treatment
   a. A-2 FEB (14,000 acres) located in the EAA north of STA-3/4.
2. Northern Distribution and Conveyance (Northern WCA-3A)
   a. Hydrologic Restoration Feature, 3-mile long spreader canal located west of S-8 Structure.
   b. Backfill Miami Canal from S-8 to I-75.
3. Southern Distribution and Conveyance (Southern WCA-3A/B, ENP)
   a. Increased S-333 Capacity from 1,500 to 3,000 cfs
   b. Two 500 cfs Gated Structures in L-67A West of Blue Shanty
   c. Blue Shanty Training Levee in WCA-3B
   d. Degrade of L-67C Levee in Blue Shanty Flowway
   e. One 500 cfs Gated Structure East of Blue Shanty and 6,000 ft of degraded L-67C levee
   f. Degrade L-29 Levee in Blue Shanty Flowway
   g. New Divide Structure (S-333B) West of Western Bridge
   h. Degrade of L-67 Extension Levee
4. Seepage Management (L-31N Levee)
   a. Increase S-356 from 500 to 1,000 cfs
   b. Partial Seepage Barrier (5-Miles Long) along L-31N
   c. Modification of G-211 Flood Control Operations

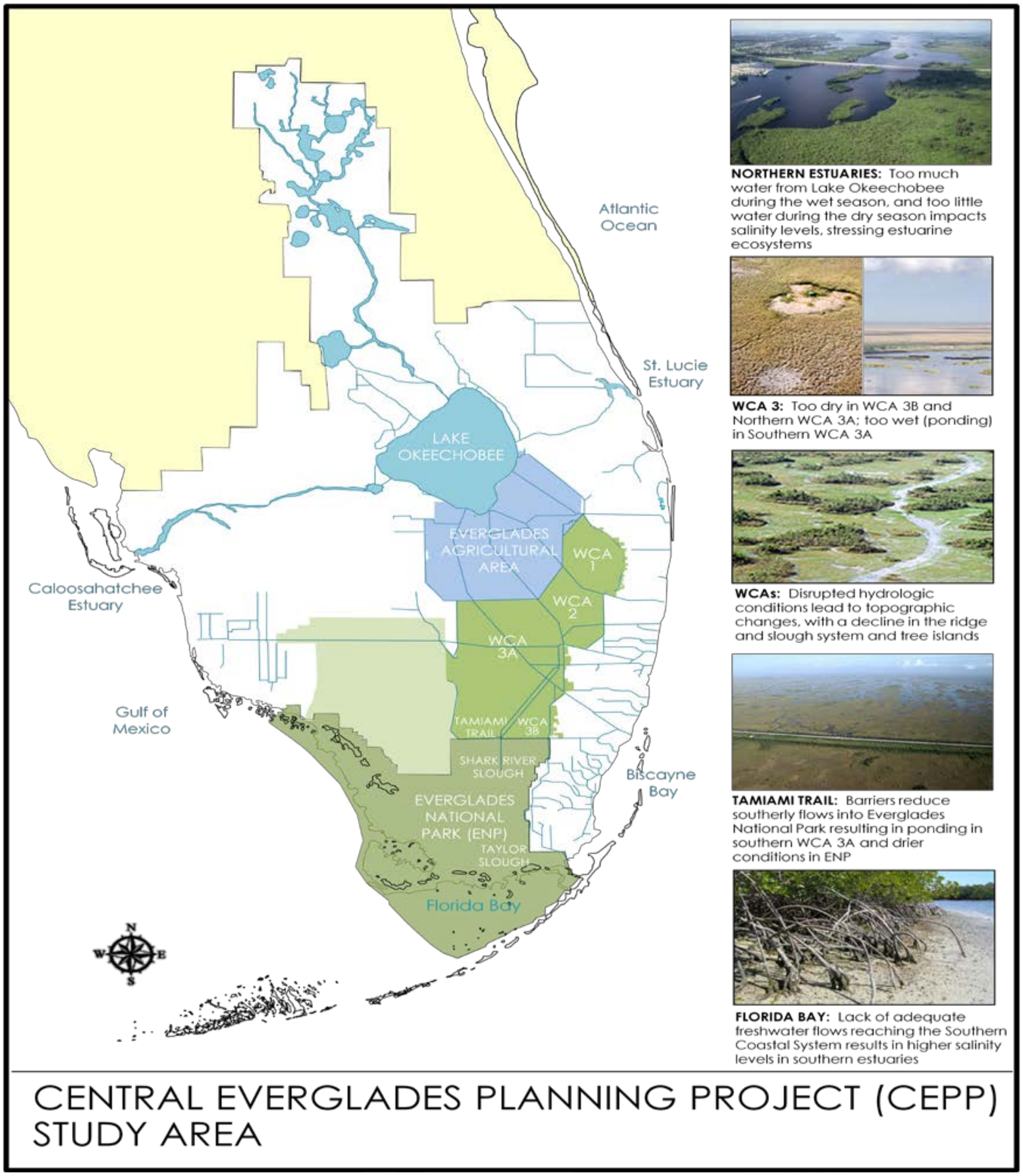

Figure D.2.1: Central Everglades Planning Project Study Area

2.2 Project Objectives

The monitoring stations described in this document are referenced to satisfy requirements of the Comprehensive Everglades Restoration Plan Project Implementation Report and requirements of (issued or pending) Department of the Army 404 permits and/or State of Florida 373.1502 Comprehensive Everglades Restoration Plan Regulation Act (CERPRA) permits for Start Up and Operational Phase Monitoring. This plan provides an outline for quantifying the quality of surface water entering and downstream of the project area for a period of ten years.

Surface water samples have been collected and analyzed for multiple constituents and at various frequencies within South Florida from stations adjacent to or nearby the targeted project features. These baseline data are compiled in the South Florida Water Management District's DBHYDRO database and in the annual South Florida Environmental Report (SFWMD 2012). Other organizations also collect surface water quality data in this region that may be relevant to the project as baseline data. To access relevant data, contact the program manager at the South Florida Water Management District.

The water quality data obtained under this program will be used to:

1. Evaluate water quality status and trends;
2. Assess compliance with federal and state water quality statutes, the EFA, and the applicable Everglades Consent Orders;
3. Guide mid- and long-term resource management decisions as part of the adaptive management plan for the project.

2.3 Active Mandates and Permits

Water quality monitoring of inflows to the Everglades Protection Area is generally governed by the 1992 Consent Decree, and Everglades Forever Act permits, most notably the Non-Everglades Construction Project permit and the STA permits. Monitoring of marsh stations is generally governed by the 1992 Consent Decree, the TP Rule, and the 2012 Consent Order. CEPP project features may also require the establishment of new monitoring locations; however, in many instances, the existing monitoring stations will be utilized to demonstrate project benefits or compliance with water quality standards. The permits and/or agreements that will govern new sampling requirements for this project will be developed through the permitting process. Since the final design and placement of the features has not been established at the time of this monitoring plan development, certain details of the actual permit required new monitoring may not exactly match the information presented in this plan.

2.4 Monitoring Components

2.4.1 Project Baseline Monitoring

Baseline sediment monitoring will be conducted in WCA-3B and northern ENP to determine the impact of water diversion and canal backfilling on sediment phosphorus content in affected areas. This baseline monitoring is necessary to establish pre-project sediment conditions in areas where no prior sediment sampling has been conducted in the past.

2.4.2 Construction Monitoring

Construction monitoring will be limited to turbidity sampling as required by FDEP construction permits. This monitoring is not included here since it is normally carried out by the construction contractor.

2.4.3 Post-Construction Monitoring (Effectiveness Monitoring)

Post-construction monitoring will be done to assess the compliance of project features with state and federal water quality statutes and applicable Everglades Consent Orders. The list of monitored parameters includes total phosphorus (TP), ortho-phosphorus (OPO4), total kjedahl nitrogen (TKN), nitrate + nitrite (NOx), calcium (Ca), sodium (Na), sulfate (SO4), DO, pH, Color, Specific Conductance, Temperature, and turbidity.

2.4.4 Inventory of Existing Monitoring Networks

New water quality monitoring efforts associated with the CEPP project are contemplated for the central and southern portions of Everglades so a review of the existing monitoring efforts in these areas was conducted. **Figure D.2.2 through D.2.5** show the existing monitoring network for the central everglades portion of the study area. The monitoring stations shown in these figures are required to demonstrate compliance with the non-Everglades Construction Project Permit (Non-ECP permit), the 1992 Consent Decree (commonly refered to as the “Settlement Agreement”) and/or the Everglades Forever Act (TP-rule). **Figure D.2.2** shows the existing structure monitoring locations within WCA-3. Monitoring at these structure locations is generally required by the Non-ECP permit. **Figure D.2.3** shows the existing structure monitoring locations within ENP, along the L-29 levee (S12s, S333, S334, S355A/B, S356) and along the L-31N/C-111 levee canal (S332s, S176, S-18C, S-197). **Figure D.2.4** shows the existing marsh monitoring locations within WCA-3, and **Figure D.2.5** shows the existing marsh monitoring locations within ENP. On these two figures, the monitoring stations identified with a circle are monitored as required in the Total Phosphorus Rule (FAC 62-302.540) and those identified with diamonds are required as part of the Settlement Agreement. Monitoring at TP-Rule sites is limited to Total phosphorus collected on a monthly basis. Monitoring at the Settlement Agreement marsh sites includes temperature, Specific Conductance., dissolved oxygen (DO), pH, total phosphorus (TP), total dissolved phosphorus (TDP), ortho-phosphorus (OPO4), alkalinity (Alk), Ca, chloride (Cl), potassium (K), magnesium (Mg), sodium (Na), sulfate (SO4), dissolved silica (SiO2), Color, total suspended solids(TSS), total dissolved solids (TDS), dissolved organic carbon (DOC), and Turbidity. This monitoring is done on a monthly basis.

Since the CEPP project does not include any features in the Caloosahatchee or St. Lucie Estuaries, no new additional monitoring will be done there for the CEPP project. No maps of the existing monitoring programs are provided for the two estuaries since no additional monitoring is contemplated in these areas.

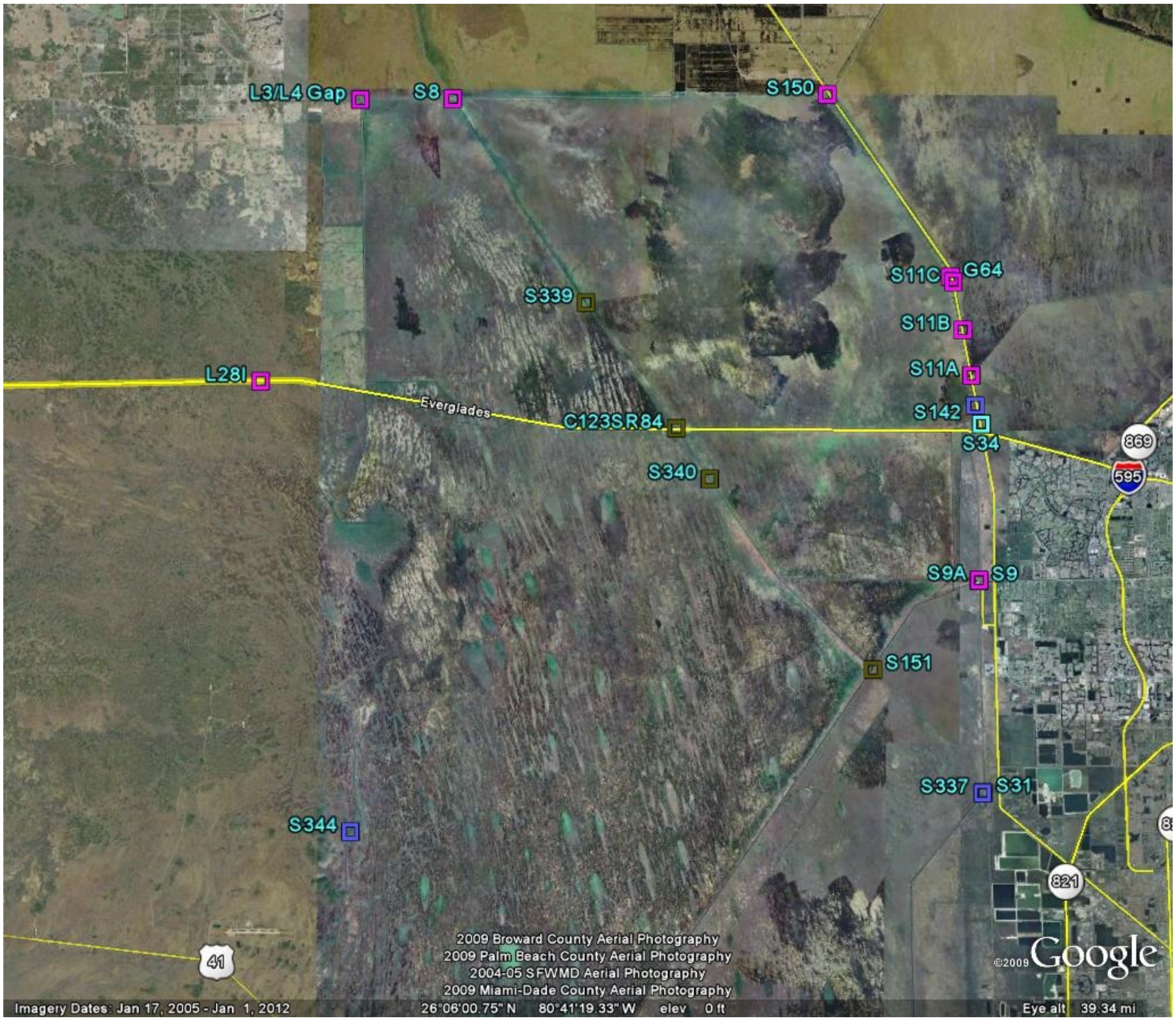

Figure D.2.2: Existing Structure Monitoring Locations in WCA-3A/B

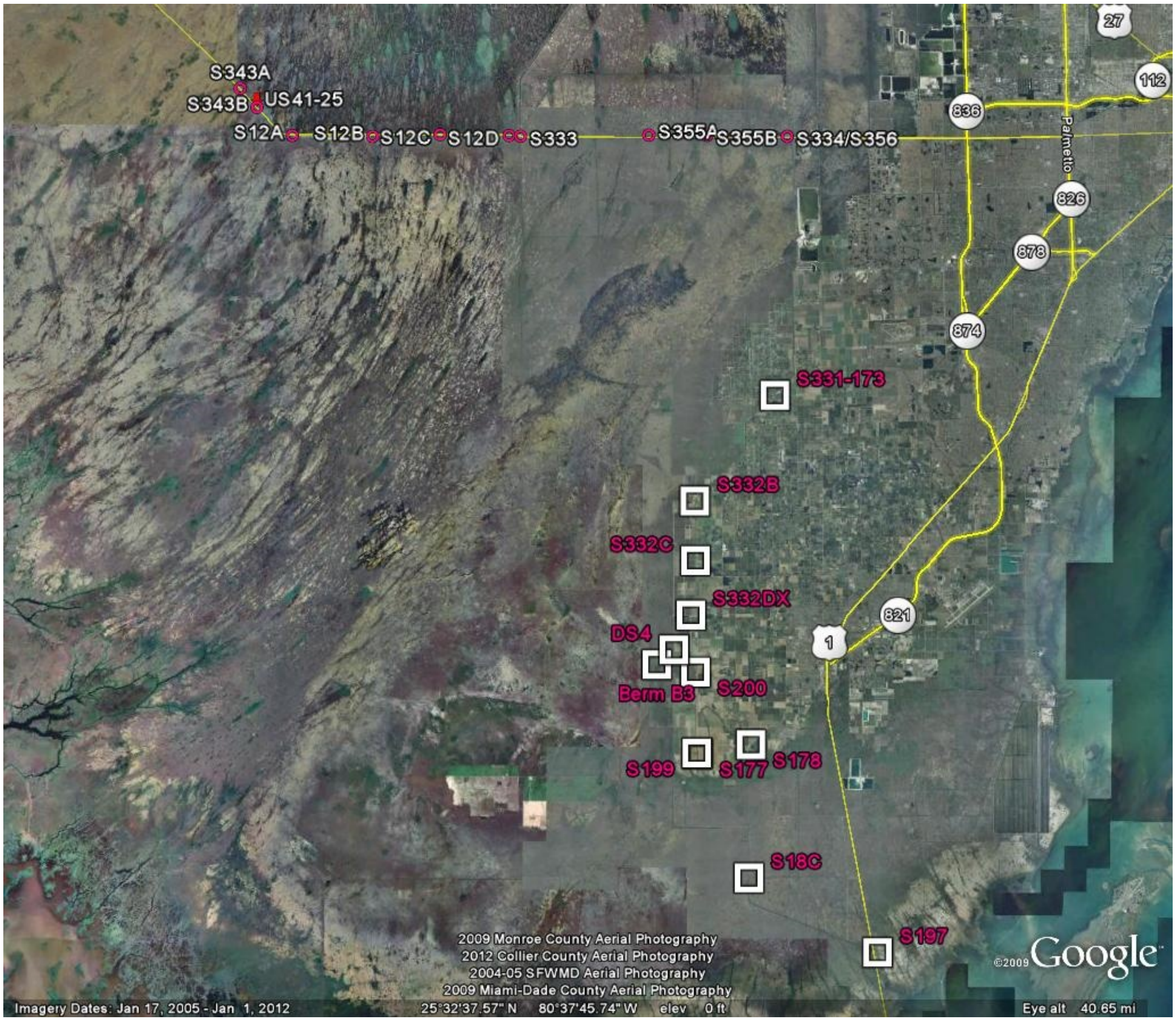

Figure D.2.3: Existing Structure Monitoring in ENP

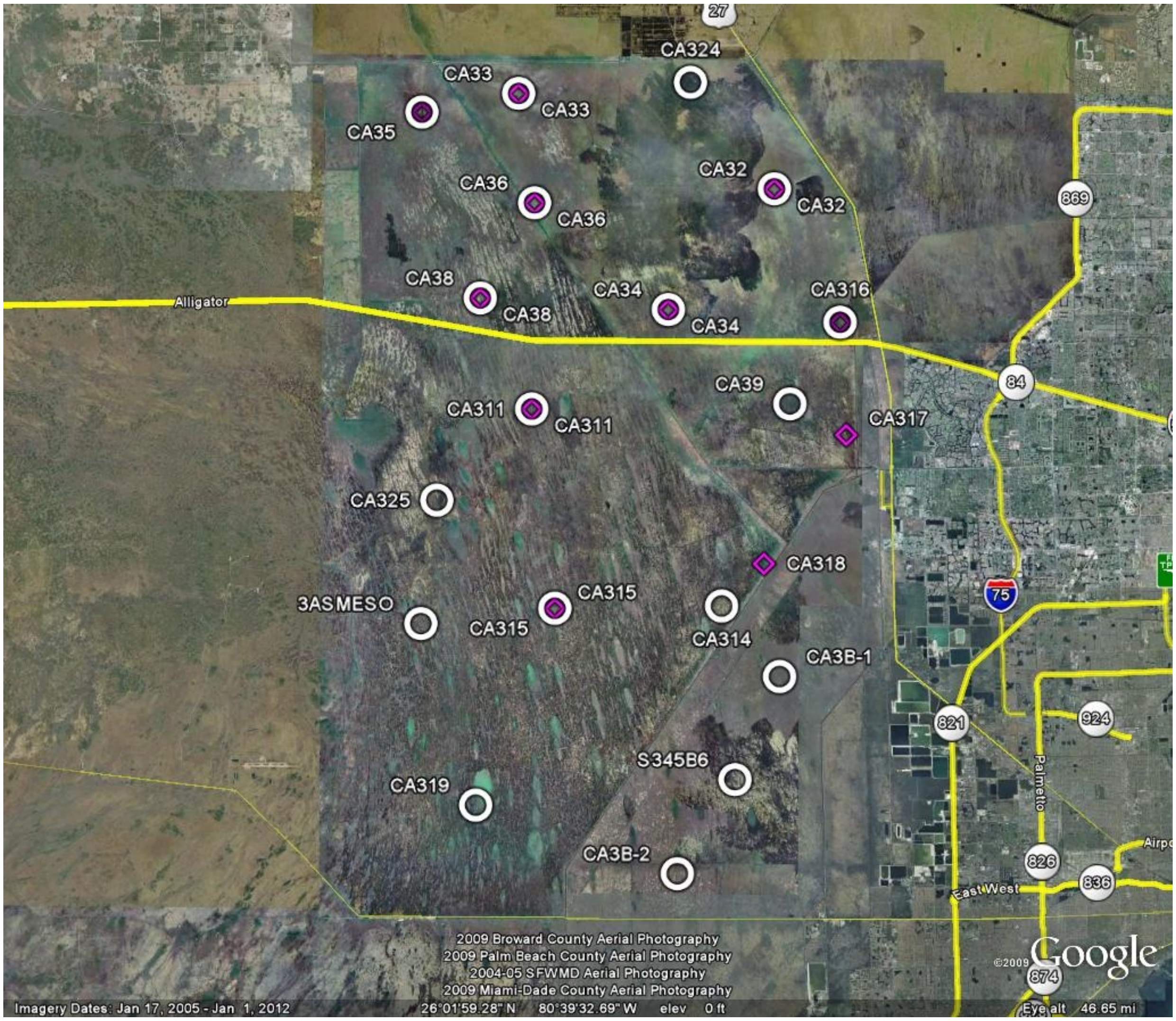

Figure D.2.4: Existing Marsh Monitoring Loactions in WCA-3A/B

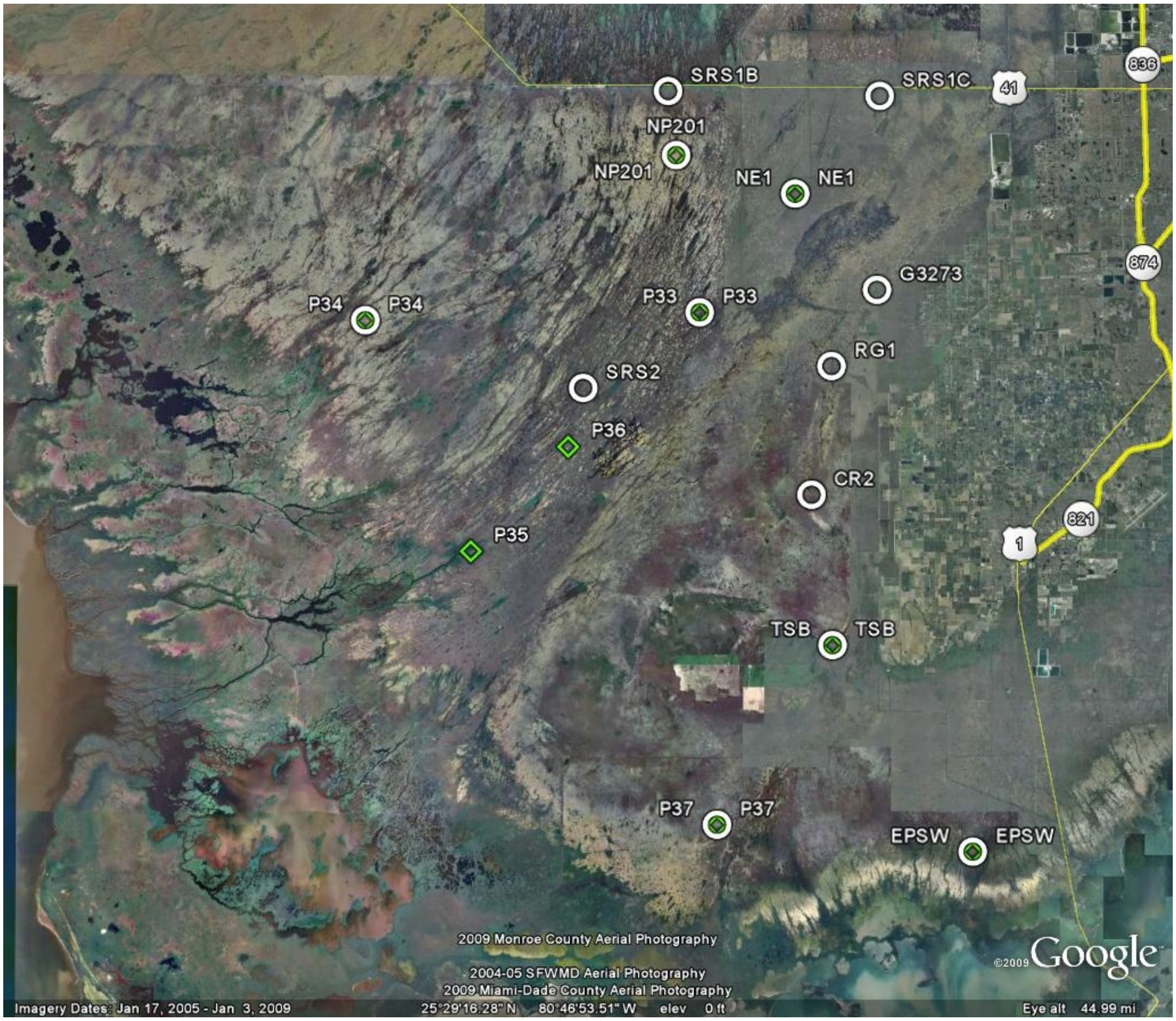

Figure D.2.5: Existing Marsh Monitoring Locations in ENP

2.4.5 Integration of Monitoring Components

New monitoring stations proposed as part of this project were selected based upon a review of the ongoing monitoring and the expected compliance requirements associated with the planned project features. Staff from SFWMD, USACE, DOI, and FDEP were consulted to ensure that the new monitoring stations were consistent with the permit requirements and not duplicative of ongoing monitoring at existing stations.

2.5 Duration

The USACE project life-cycle for the CEPP project is defined as the period between 2015 and 2050. This monitoring plan includes funding for the first 10-years of monitoring since this is generally the period when these costs are cost-sharable. The duration of cost-shared project related monitoring required for compliance with the EFA, non-ECP, the Settlement Agreement, or future CERPRA or LOPA permit permits is assumed to be 10-years. Project level monitoring is likely to continue after this period; however, this is not addressed in this plan. Changes to CEPP water quality monitoring efforts are keyed to future changes to any of the controlling laws, settlements, or permits. Since project construction will occur over a period of 10-years or so, monitoring efforts at some project features will not begin for several years after congressional authorization. It is intended that monitoring at individual stations be covered under this plan for a 10-year period regardless of when the first year of monitoring occurs. Since the project will be constructed over a period exceeding 10-years, the duration of cost-shared monitoring for the project will extend past 10-years; however, no monitoring activity associated with a single project feature will be cost-shared for more than 10-years.

The monitoring plan will be periodically reviewed for effectiveness and modified as allowed under permitting constraints. As part of an adaptive management approach to this project, it is expected that the requirements to monitor particular parameters and frequencies may be change throughout the life of this project. In the event that monitoring reduction is warranted, demonstration that a parameter or group of parameters no longer represents a source of concern will be required. Project Initiation

The water quality monitoring plan was initiated by the Water Quality Sub-team of the CEPP, and technical review was provided by Comprehensive Everglades Restoration Plan Restoration, Coordination and Verification staff of the South Florida Water Management District and the U.S. Army Corps of Engineers. Development of this plan is required as part of the Project Implementation Report document. The project implementation report development phase calls for sections detailing the water quality monitoring and adaptive assessment methods for the selected alternative. The plan was originally prepared under the assumption that water quality monitoring efforts directly funded by this project will last a total of ten years. This is consistent with the duration of the CERPRA permits that will be required for the project.

2.5.1 Modification or Termination Conditions

Modification of the water quality monitoring plan will be determined by the needs of the project annually, and will be completely reassessed after five years from initiation. This plan may be changed to reflect any future design changes or permit requirements. It also may be terminated according to permit expiration dates or changes to the project objectives. The plan will be reviewed and modified annually or more frequently if necessary to reflect new requirements. Decisions to adjust monitoring will be coordinated through the project partners as well as the FDEP.

This CEPP monitoring plan was developed assuming that major, ongoing monitoring programs that are not funded directly by the Project would continue to supply data relevant to the Project. Should any of these programs be discontinued or significantly curtailed, then the Federal and local sponsors of the Project will reevaluate monitoring priorities and may redistribute funds for the benefit of the Project, even potentially not funding elements of this monitoring plan.

2.6 Monitoring/Sampling Locations and Naming Convention

A description of new or existing monitoring for each project feature is provided below.

2.6.1 Optimized Lake Okeechobee Operations

Optimization of the LOR08 operations will result in improved hydrology in Lake Okeechobee, Caloosahatchee Estuary, and the St. Lucie Estuary; however, this will not require any changes to the existing monitoring networks in these three ecosystems. No new monitoring is proposed in these areas as a result of this project.

2.6.2 A-2 Flow Equalization Basin

Monitoring of the A-2 FEB was discussed by the CEPP Water Quality Monitoring Sub-team in January of 2013. The team determined that regulatory monitoring of the inflows and outflows was necessary as well as well as optimization monitoring at one station within the FEB. Start-up and follow-up monitoring of pesticides and heavy metals for this facility is included in Sections 2.19 and 2.20 of this plan. The A-2 FEB has not been designed as of March 2013 the specific names, locations, and number of monitoring stations have not been finalized; however, the team determined that one inflow sampling site and two outflow sampling sites and one is the likely configuration for the compliance monitoring requirement. Optimization monitoring at one internal site is also included. The parameters and frequencies for routine monitoring at this FEB are shown in **Table D.2.1**. The annual cost for compliance monitoring is estimated to be $77,000 which includes approximately 520 hours of staff time, a vehicle, and $23,000 for laboratory analysis of samples from three sampling stations. The annual cost of optimization monitoring is estimated to be $78,000 which includes 520 hours of staff time, vehicle use, boat use, and $7,800 in laboratory analysis of samples from one sampling station. The total cost of monitoring the A-2 FEB is estimated to be $155,000.

Table D.2.1: Monitoring Plan for A-2 FEB

Sampling Locations	Sample Type	Sampling Frequency	Parameter
Inflow and 2 Outflows, and one internal location	Grab Sample	Weekly if recorded flow (WRF)	Specific Conductance, Color, pH, Dissolved Oxygen), Temperature, TP
	Grab Sample	Biweekly if recorded flow (BWRF)	TKN, NOX, SO4

2.6.3 Northern WCA 3A Spreader Canal West of S-8

A three mile long spreader canal is proposed south the L-4 canal and west of the S-8 structure. This spreader canal that discharges from the EAA into the Water Conservation Areas will be subject to the requirement of a CERPRA permit and the Settlement Agreement). The design and operation of this spreader canal will affect the number and placement of new monitoring sites. Since the spreader canal will not be designed prior to publishing the PIR, the WQ monitoring sub-team determined that a placeholder of three sampling sites can be used to develop the monitoring plan costs used in this document. **Table D.2.2** provides the sampling scheme for these monitoring locations. The estimated cost for conducting this sampling is $78,000 which includes 520 hours of staff time, vehicle use, and $24,000 for laboratory analytical cost for samples collected from three stations.

Table D.2.2: Monitoring Plan for Spreader Canal at North End of WCA 3A

Sampling Locations	Sample Type	Sampling Frequency	Parameter
NWCA3_1, NWCA3_2 NWCA3_3	Grab Sample	BWRF	Specific Conductance, Color, pH, Dissolved Oxygen, Temperature, TP, OPO4, TKN, NOx, Na, Ca, SO4, and Turbidity

2.6.4 Miami Canal Backfill

Backfilling the northern portion of the Miami Canal will impact marsh hydrology in the vicinity of the canal. The CEPP WQ monitoring team has reviewed the existing marsh monitoring efforts and determined that the ongoing monitoring is sufficiently dense in the vicinity of the backfilled canal that no additional monitoring is required. **Table D.2.3** includes a list of the existing monitoring stations and sampling scheme. No new monitoring is proposed so there is no project cost.

Table D.2.3: Existing Sampling in the Vicinity of the Miami Canal Backfill

Sampling Locations	Sample Type	Sampling Frequency	Parameter
CA33, CA34, CA35, CA36, CA38, CA324	Grab Sample	Monthly	Specific Conductance, Color, pH, Dissolved Oxygen, Temperature, TP, TDP, OPO4, Alk, Ca, Cl, K, Mg, Na, SO4, SiO2, TDS, TSS

2.6.5 L-67 A / C Features

Three new structures are proposed for the L-67A levee and partial levee degrading is proposed for the L-67C levee. This will require a CERPRA permit monitoring condition, and be subject to the Settlement Agreement. Depending on policy and legal implications, the two new structures west of the Blue Shanty levee may be used to calculated Settlement Agreement compliance for Shark River Slough. No new monitoring is proposed for the cuts in the L-67C canal. **Table D.2.4** shows the locations and sampling scheme for the new structures in the L-67A levee. The estimated cost of conducting this sampling is $111,000 which includes 830 hours of staff time, vehicle use and $24,000 for analytical costs for the three stations. Additional staff time was estimated for these sites given the remote location of the three stations.

Table D.2.4: Sampling Locations and Scheme for New Structures in the L-67A Canal

Sampling Locations	Sample Type	Sampling Frequency	Parameter
S-631, S-632, S-633	Grab Sample	WRF	Specific Conductance, Color, pH, DO Temperature, TP
	Grab Sample	BWRF	TKN, NOX, SO4

2.6.6 **L-67 Extension Backfill**

Filling of the L-67 Extension Canal may impact water quality in the northern ENP marsh as well as impact ponding and sedimentation south of the S-12D structure. The CEPP Water Quality Monitoring team reviewed the ongoing marsh monitoring network south of Tamiami Trail and determined that the existing P33 station would provide sufficient monitoring in this area. The team also determined that periodic sediment cores downstream of the S12D structure are necessary to monitor changes in sedimentation and sediment content. **Table D.2.5** contains a list of the planned sediment sampling parameters and frequencies. The estimated cost of sediment marsh monitoring is $17,000 which includes 20 hours of staff time, helicopter use, and $5,000for analytical expenses. The estimated cost of marsh water quality monitoring is $20,000 which includes 50 hours of staff time, helicopter use, and $3,600 for analytical expenses. The total cost of monitoring the L-67 Extension Backfill is $37,000 per year. This monitoring is scheduled to begin at the initiation of the construction of the backfill work so that there is sufficient time to collect baseline sediment samples.

Table D.2.5: New Sediment Sampling Locations South of the S-12D Structure

Sampling Locations	Sample Type	Sampling Frequency	Parameter
SRS-S1, SRS-S2, SRS-S3	Sediment Grab Sample	Biennially	TP, SO4, TOC, TN, organic matter, bulk density, and depth.
L67E Marsh Site	Water Grab Sample	Monthly	Specific Conductance (uS/cm), Color (PCU) , pH(SU), Dissolved Oxygen (mg/l), Temperature (deg. C), TP (mg/l), TDP, OPO4, Alkalinity, Ca, Cl, K, Mg, Na, SO4, SiO2, TDS, TSS

2.6.7 **Blue Shanty Flow-way**

Construction of the Blue Shanty Flowway includes construction of a training levee from the L-29 Levee north to the L-67A levee along the existing Blue Shanty Canal right-of-way, construction of a new divide structure (S-333B) in the L-29 levee just west of the western Tamiami Trail Bridge, and the degradation of the L-29 levee between the S-333 and S-333B structures. The CEPP WQ monitoring sub-team determined that new monitoring would be required at the S-333B structure but that no additional monitoring would be necessary along the degraded portion of the L-29 levee, within the bridge flow paths, or in the marsh adjacent to the Blue Shanty training levee. **Table D.2.6** provides a summary of the monitoring at the planned divide structure. The estimated cost for conducting the monitoring at the L-29 Canal Divide Structure is $30,000 per year which includes 210 hours of staff time, vehicle use, and $7,800 in analytical expenses. The estimated cost for conducting the marsh water quality monitoring is $20,000 per year which includes 50 hours of staff time, helicopter use, and $3,600 in analytical expenses. The total cost for new monitoring at the Blue shanty Flow-way is estimated at $50,000 per year.

Table D.2.6: Monitoring Scheme for the Blue Shanty and Divide Structure

Sampling Locations	Sample Type	Sampling Frequency	Parameter
B.S. Marsh Monitoring	Grab Sample	Monthly	Specific Conductance, Color, pH, Dissolved Oxygen, Temperature, TP, TDP, OPO4, Alk, Ca, Cl, K, Mg, Na, SO4, SiO2, TDS, TSS
L-29 Canal Divide Structure	Grab Sample	WRF	Specific Conductance, Color, pH, Dissolved Oxygen, Temperature, TP
	Grab Sample	BWRF	TKN, NOX, SO4

2.6.8 **L-29 Degrade**

The L-29 levee will be degraded between the S-333 Structure and the new L-29 Canal divide structure. Monitoring downstream of this area will be done to document impacts to marsh areas. **Table D.2.7** provides a summary of the monitoring at the planned divide structure. The estimated cost of monitoring at this location is $20,000 per year which includes 50 hours of staff time, helicopter use, and $3,600 for analytical expenses.

Table D.2.7: Monitoring Scheme L-29 Degrade

Sampling Locations	Sample Type	Sampling Frequency	Parameter
L-29 Degrade Marsh Monitoring	Grab Sample	Monthly	Specific Conductance, Color, pH, Dissolved Oxygen, Temperature, TP, TDP, OPO4, Alk, Ca, Cl, K, Mg, Na, SO4, SiO2, TDS, TSS

2.6.9 **L-31N Seepage Cutoff Wall and Operational Changes to G-211**

The L-31N Seepage Cutoff Wall will be placed within the levee cross-section and the operations of the G-211 structure will be modified. The CEPP WQ monitoring sub-team determined that these project features will not require new monitoring since any changes to surface water quality will be reflected in the ongoing monitoring at the nearby structure monitoring locations (S331, etc.). **Table D.2.8** provides a summary of the monitoring at the planned divide structure. The estimated cost of monitoring at this location is $20,000 per year which includes 50 hours of staff time, helicopter use, and $3,600 for analytical expenses.

Table D.2.8: Monitoring Scheme L-31N Seepage Cutoff Wall and Operational Changes to G-211

Sampling Locations	Sample Type	Sampling Frequency	Parameter
L-31N Seepage Cutoff Wall	Grab Sample	Monthly	Specific Conductance, Color, pH, Dissolved Oxygen, Temperature, TP, TDP, OPO4, Alk, Ca, Cl, K, Mg, Na, SO4, SiO2, TDS, TSS

2.6.10 S-356 Flow Capacity Increase

The plan includes increasing the S-356 capacity from 500 cfs to 1,000 cfs. The CEPP WQ monitoring sub-team determined that the existing Settlement Agreement monitoring efforts at this structure was sufficient and no additional monitoring at this station was warranted.

2.6.11 S-333 Flow Capacity Increase

The plan includes increasing the S-333 capacity from 1,500 cfs to 3,000 cfs. The CEPP WQ monitoring sub-team determined that the existing Settlement Agreement monitoring efforts at this structure are sufficient and no additional monitoring at this station was warranted.

2.6.12 Geographic Location of Monitoring Stations

The exact location of the new monitoring stations has not been determined at this time. After project authorization, this monitoring plan will be revised to include the latitude and longitude of each new station.

2.6.13 Access and Authority

New Monitoring stations located at water control structures will be accessed via existing levees or public roadways. Triennial sediment monitoring within ENP will either be conducted using airboats or with helicopters depending upon location and season. To perform environmental sampling within Everglades National Park, a sampling and access permit will first be obtained from the park service.

2.7 Project Reporting

Reporting for project monitoring conducted to comply with the Settlement Agreement, Non-ECP permit, or EFA will be accordance with the applicable requirements. Project monitoring that is not tied to those requirements will be reported on in accordance with the applicable CERPRA permit requirement.

2.7.1 Frequency

Monitoring results will be reported no less frequently than annually.

2.7.2 **Content and Format**

The content and format of the monitoring reports have either been previously established by the applicable permit or settlement. In the case of yet to be issue permits, the content and format will be determined at the time of permit issuance.

2.7.3 **Report Recipients and Broader Distribution**

The recipients for the monitoring reports include: 1) regulators from the USEPA and FDEP; 2) scientists from local, state, and federal agencies; and 3) non-governmental organization scientists and the general public. Distribution of the reports will be via email and web link.

2.7.4 **Revisions and Modifications**

[This section is reserved for future changes as they are made and should be referenced throughout the document as revisions occur. Sections should be added chronologically. As revisions are made, a note should be added to the corresponding section of the plan.]

2.8 Administration and Implementation of the Monitoring Plan

Training or Certification: Field and laboratory training requirements are specified in the FDEP SOPs and FSQM for the field and in the NELAP standard and CLQM for the laboratory

2.8.1 **Organization Structure and Responsibilities**

Overall project organization and responsibilities are detailed in the South Florida Water Management District Water Quality Bureau (WQB) Quality Management Plan (QMP). Field activity responsibilities are detailed in the District's Field Sampling Quality Manual (FSQM). Laboratory analysis and data validation responsibilities are detailed in the District's Chemistry Laboratory Quality Manual (CLQM). These documents define the procedures used by SFWMD personnel to meet the Florida Department of Environmental Protection's (FDEP) Quality Assurance Rule, Florida Administrative Code (F.A.C.) 62-160. Refer to these documents for details on key personnel and relevant responsibilities.

2.8.1.1 Monitoring Program Manager (or Project Manager)

The monitoring program manager is responsible for overseeing the monitoring procedures and determining Reporting Leads. This person will make sure all Leads and Managers are following procedure.

Name : To Be Determined (TBD)
Address:
Telephone:
Email address:

2.8.1.2 Monitoring Field Project Manager

The field project manager for this project is *[INSERT: name]*. The field project manager is responsible for maintaining this document and making sure that any changes are well documented and communicated to the field staff and other parties as necessary.

Name: TBD
Address:
Telephone:
Email address:

2.8.1.3 Monitoring Field Lead

Name: TBD
Address:
Telephone:
Email address:

2.8.1.4 Analytical Lead/Contract Manager

Name: TBD
Address:
Telephone:
Email address:

2.8.1.5 Quality Assurance Lead

Name: TBD
Address:
Telephone:
Email address:

2.8.1.6 Reporting Lead

Name: TBD
Address:
Telephone:
Email address:

2.8.1.7 Program Implementation

This monitoring plan is part of a federal-state cost shared project. The USACE is likely to be responsible for constructing most of the project features. Monitoring efforts during start-up as well as regular operation will likely be conducted by the SFWMD given its extensive experience conducting on-going environmental monitoring. Partnerships

The SFWMD may chose to engage local governments or private contractors to conduct the monitoring outlined in this plan.

2.8.1.8 Program and Protocol Review

Review Summary (to be completed by RECOVER QAOT)

[List the reviews that the monitoring plan has undergone (i.e. RECOVER, QAOT) and the reviews that are expected in the future (i.e. scope of work (SOW) review by the QAOT and any Standard Operating Procedures (SOPs) that need to be reviewed by the QAOT). Additionally, technical representatives of the respective monitoring units of the Federal and local sponsor should review SOPs and SOWs. Also list if there will be any periodic reviews (annually, biannually, etc), and by whom. Items that might be considered in a periodic review:

- *Are the right parameters or indicators being monitored?*
- *Are the SOPs appropriate, do they need to be modified, or new SOPs developed?*
- *Is the project management structure working effectively or are changes in roles and responsibilities required?*
- *Do the project results demonstrate the verity of conceptual models, restoration hypotheses, and restoration techniques utilized? If not, how will findings be utilized and findings made in monitoring program review?].*

2.9 Cost Estimates

Estimated costs are provided below in **Table D.2.9.**

Table D.2.9: Estimated Project Water Quality Monitoring Cost

Feature	Monitoring Description	Annual Cost	1-Year	5-year	10-year
A-2 FEB					
	Inflows / Outflows	77,000	77,000	385,000	770,000
	Internal Optimization	78,000	78,000	390,000	780,000
	Start up Toxicants				
	Start-Up (year 1)	30,000	30,000	30,000	30,000
	Stabilization (years 2-3)	25,000		50,000	50,000
	Routine (years 4-9)	15,000		30,000	90,000
Northern WCA 3A					
	Marsh Water Quality	78,000	78,000	390,000	780,000
L-67A/C Structures					
	Structure Compliance	111,000	111,000	555,000	1,110,000
L-67 Extension Backfill					
	Marsh Water Quality	20,000	20,000	100,000	200,000
	Marsh Sediment	17,000	17,000	85,000	170,000
Blue Shanty Flow-way					
	Structure Compliance	30,000	30,000	150,000	300,000
	Marsh Water Quality	20,000	20,000	100,000	200,000
L-29 Degrade					
	Marsh Water Quality	20,000	20,000	100,000	200,000
L-31N					
	Marsh Water Quality	20,000	20,000	100,000	200,000
Total, Field Work and Analytical Cost			501,000	2,465,000	4,880,000
	Reporting Cost		10,000	50,000	100,000
Total Cost			511,000	2,515,000	4,980,000
Total Cost with Contingency (assume 20%)			**613,200**	**3,018,000**	**5,976,000**

2.10 Water Quality Monitoring

2.11 Data quality objectives

While it is recognized that data quality objectives (DQOs) are typically developed separately for each specific monitoring project, all mandated monitoring conducted by the SFWMD must meet the objectives conveyed in the FDEP's Quality Assurance Rule, 62-160 F.A.C. The SFWMD has adopted a uniform set of DQOs following criteria detailed within the "Analytical Methods and Default QA/QC Targets" table of the SFWMD's Chemistry Laboratory Quality Manual (CLQM). For those samples analyzed by the FDEP Laboratory, the SFWMD has adopted the DQOs within the most recent version of the FDEP's Laboratory Chemistry Quality Manual.

Water Quality and sediment samples, including field testing and field quality control samples, are collected in accordance with the FDEP Quality Assurance Rule, 62-160 F.A.C. and the current version of the Field Sampling Quality Manual (SFWMD-FIELD-QM-001) (FSQM). Applicable sections of the FSQM include, but are not limited to, field sample collection procedures, decontamination procedures, field testing, quality control requirements, and documentation requirements.

The DQOs of the field testing parameters for this project are specified in the field testing section of the FSQM. This manual is updated annually, and therefore, the most recent version of the FSQM details the specific field testing data quality objectives for this project at the time of sample collection.

Samples are analyzed according to the provisions within the FDEP Rule 62-160 F.A.C. and the CLQM. This manual is annually updated, and therefore, the most recent version of the CLQM details the specific laboratory analyses' DQOs for this project at the time of sample collection

Data not meeting the quality objectives must be qualified using standard FDEP qualifier codes (F.A.C. 62-160) and corrective actions may be taken as outlined in the SFWMD's FSQM and CLQM and Data Validation and Reporting Sections SOPs.

2.12 Monitoring Data Elements/Indicators

Monitoring proposed for this project is primarily required for compliance with existing or future permits or the Settlement Agreement. In addition to demonstrating compliance with water quality criteria, the data collected under this plan is referenced in the CEPP Adaptive Management Plan. Discussion of decision-criteria is found in that plan.

2.12.1 Procedures and Methods

Sampling methods will follow well-defined methodologies that have been approved by Federal and state regulatory agencies. The SFWMD's FSQM shall be used for all water quality and sediment sampling procedures. Once the DQOs are established, the QASR should be consulted to identify the analytical methods that will meet the project objectives. Methods specified in the CLQM or their equivalent shall be used when specified.

The laboratory that processes the samples collected in this plan will report data using ADaPT (Automated Data Processing Tool) software. Staged Electronic Data Deliverable (SEDD)(http://www.epa.gov/fem/pdfs/sedd_adr_imp_overview.pdf) or the Automated Data Review (ADR) software may be used in addition to ADaPT.

Each discrete sample will be assigned a unique sample identification number that ensures that it can eventually be retained as a unique database record linked to a specific location. All these activities regarding a sample will be documented in a format that assures that the resulting data are traceable and of known and documentable quality.

2.12.2 Laboratory Qualifications

Laboratories used in this plan will be certified by the Florida Department of Health Environmental Laboratory Certification Program (FDOH ELCP). At the time the laboratory(s) are selected, this plan will be updated to include the laboratory certifications by the test method, analytes/parameters and matrix that are reported for the project. As specified by QASR Chapter 4.0, laboratories used for analysis of CERP environmental samples will be pre-approved and subjected to comparative testing if available, such as the performance evaluations overseen by the QAOT. These requirements shall be defined in the laboratory's contract or work order with the contracting agency.

2.12.3 Rationale for indicator selection

Field and Laboratory analytes are collected per the requirements of the EFA, Settlement Agreement, and anticipated CERPRA and EFA permits. The focus of the monitoring efforts is on the collection of macronutrients as they are used as indicators of restoration success or project impact.

2.12.4 Sampling frequency and duration

Sampling frequencies proposed in this monitoring plan are either directly the result of the requirements of the EFA, Settlement Agreement, or Non-ECP permit, or are anticipated to be required for future EFA or CERPRA permits.

2.12.5 Assessment Process and Decision Criteria (triggers and thresholds)

Assessment frequency is annual as established by the requirements of the EFA, Settlement Agreement or Non-ECP permit. Decision criteria are established by the compliance values from these cited permits and settlements.

2.13 Data Collection

2.13.1 Sample/Data Collection Standards and Ethics

Every person performing field sampling must commit to following project specific requirements, SFWMD's FSQM, field SOPs, QASR requirements, and other instructions as issued, to assure that samples collected are of known and documented quality and are defensible.

2.13.2 Sample Submission

Requirements for sample handling, custody and analysis holding times are detailed in the ***SFWMD's Chemistry Laboratory Quality Manual and FDEP SOPs (DEP-SOP-001/01).***

2.13.3 Chain of Custody

The Chain of Custody (COC) must accompany all samples submitted to internal or external laboratories. A COC form documents the possession of the samples from the time of collection to receipt in the laboratory. A COC form will be utilized and must be signed by the collector before it is relinquished to the laboratory. Field documentation must conform to the requirements specified in FDEP SOP FD1000 and the field documentation section of the SFWMD FSQM.

2.13.4 **Quality Control of Samples**

2.13.4.1 Laboratory Quality Control

Laboratories must meet NELAC requirements, the requirements detailed in Chapter 4 of the CERP QASR (http://www.evergladesplan.org/pm/program_docs/qasr.aspx) and applicable requirements as detailed in FDEP's Quality Assurance Rule, 62-160 F.A.C. All laboratory and applicable quality control data shall be submitted to the District in the ADaPT compatible format.

2.13.4.2 Field Quality Control Samples

Field Quality control samples will comply with the Field Quality Control section of the FSQM, Florida Department of Environmental Protection (FDEP) requirements (DEP-SOP-001/01,), and those developed in the DQO process. All requirements in the FDEP's Quality Assurance Rule should also be followed.

2.13.5 **Field Record and Data Review**

Field record and data review procedures are specified in the SFWMD FSQM and associated SOPs Responsibilities of the Laboratory Data Validation

Data validation shall be performed in accordance with the requirements detailed in Chapter 5 of the CERP QASR. When preparing the ADaPT file the laboratory will review the data for completeness and accuracy.

2.13.6 **Data Storage and Archiving**

Long-term maintenance and management of digital information are vital to all PLMPs. Maintaining and managing digital data, documents, and objects that result from projects and activities is the responsibility of all parties involved. CGM54 will be followed to help ensure the continued availability of crucial project information and permit a broad range of users to obtain, share, and properly interpret that information. After the data validation process, all data are maintained so that end users can retrieve and review all information relative to a sampling event. Field notes are maintained on an internal server either by scanning actual field note pages or by uploading narratives from field computers path to server. All analytical data and field conditions are sent to the SFWMD database (DBHYDRO) for long-term storage and retrieval. If data are not suitable for DBHYDRO they will be entered into the CERP Integrated Database (CID) on CERPZone through the Morpho interface.

SFWMD or its surrogate shall maintain records of field notes and copies of all records relative to the chain of custody and analytical data. It is the responsibility of the SFWMD or its surrogate to maintain both current and historical method and operating procedures so that at any given time the conditions that were applied to a sampling event can be evaluated. Upon completion of the project, the collecting agency shall provide all original field notes to the District's WQB for permanent archival.

Records shall be maintained for the life of the project and five years thereafter, in a manner that will protect the physical condition and integrity of the records. Storage shall follow the District's records storage procedure. Access to archived methods shall be through designated records custodian. Corrections of data or records shall follow the established SFWMD SOPs.

2.14 Documentation

Field records shall be documented in accordance with the procedures specified in the SFWMD FSQM.

2.15 Quality Assurance and Quality Control

2.15.1 Laboratory and Field Audits

Audits will be performed according to the SFWMD FSQM and associated SOPs. Audit reports will be provided to the project manager. The authority of the auditor to stop work for processes that impact the quality of the data will also be defined, along with how and to whom the audit findings are reported and distributed.

2.16 Data Analyses and Records Management

The SFWMD has adopted a uniform set of DQOs following criteria detailed by the table entitled *Field Quality Assurance Objectives* found in the field testing section of the FSQM and within the "Analytical Methods and Default QA/QC Targets" table of the CLQM.

2.16.1 Data Quality Evaluation and Assessment

The data quality assessment (DQA) process uses scientific and statistical data evaluation procedures to determine if the data are of the right type, quantity, and quality to support their intended use. The DQA process is discussed in the QASR Chapter 11 and detailed guidance is described in EPA QA/G9R, Data Quality Assessment: A Reviewer's Guide (EPA, 2006a) http://www.epa.gov/quality/qs-docs/g9r-final.pdf.

The Science Policy Council has defined general data quality assessment factors (EPA, 2003) http://www.epa.gov/osa/spc/pdfs/assess2.pdf) that should be considered during the DQA process. These include soundness, applicability and utility, clarity and completeness, uncertainty and variability, and evaluation and review**.**

Reporting on mercury and pesticides or other toxicants should be done under the supervision of professionals with a record of published research in these areas using approved guidance such as the QASR Manual and CGM 42 Toxic Substances Screening Process - Mercury and Pesticides.

2.17 Adaptive Management Considerations

Please reference the Adaptive Management Plan for the CEPP project, Annex D Part 1.

2.18 Mercury and Toxicant Monitoring

Based on the guidance contained in *"A Protocol for Monitoring Mercury and Other Toxicants"* (dated April 2011; hereafter referred to as the *Protocol*), the District shall initiate Phase 1 – Tier 2: Field Sampling for Initial Startup Monitoring Prior to Discharge for the A-2 Flow Equalization Basin (FEB) as follows:

2.19 Phase 1: Baseline Collection and Assessment

2.19.1 Phase 1 - Tier 2: Field Sampling for Initial Startup Monitoring Prior to Discharge

2.19.1.1 Mosquitofish

i) When construction of the A-2 FEB is completed, the USACE will notify the SFWMD who shall notify the Department and within one month of initial flooding collect mosquitofish from multiple locations within the A-2 FEB (to total at least 100 fish; see **Figure 5** for map). Additionally, mosquitofish (to total at least 100 fish) will be collected from a single station located in the receiving water of the project, immediately downstream of G-13. The data for the downstream station will serve as a baseline for any future evaluations of potential impacts to the receiving waters. Samples shall be physically composited into one (spatially-averaged) sample per operating unit and analyzed for total mercury (THg), cis-chlordane, trans-chlordane, dieldrin, cis-nonachlor, trans-nonachlor, toxaphene, arsenic, and copper (note, a single aliquot should be analyzed per composite).

ii) The District shall provide the Department with the results of the first collection of mosquitofish as well as the appropriate action levels for comparison (90% upper confidence level of the basin-wide average or the 75th percentile concentration for the period of record for all basins if basinwide data are not available). If tissue concentrations from the A-2 FEB are below the 90% upper confidence level of the basin-wide average or below the 75th percentile concentration for the period of record for all basins (if basin-specific data are lacking) after concurrence from the Department, the District may initiate flow-through operation and routine monitoring for the A-2 FEB.

However, if Hg or other toxicant concentrations in the mosquitofish composite exceed one of the above-referenced action levels, the District shall immediately (within 14 days of receiving quality-assured data from the laboratory) collect a sample(s) to confirm the exceedance(s). In addition, the District shall consult with the Department to determine the most appropriate course of action and obtain authorization to initiate flow-through operation. At a minimum, the course of action will include implementation of Tier 2 Expanded Monitoring and Risk Assessment by the District during initial flow-through operations (e.g., collection of monthly mosquitofish within the A-2 FEB and at one station downstream of the A-2 FEB at a minimum), additional details on expanded monitoring are provided in the *Protocol*. The recommended course of action may also include additional measures as determined to be appropriate. When results of expanded monitoring demonstrate concentration of Hg in mosquitofish from the A-2 FEB has decreased to acceptable levels (below action levels referenced above) and the concentrations at the downstream site are not significantly elevated above baseline levels, the District shall notify the Department and request that the monitoring revert back to Tier 1 routine monitoring.

2.19.1.2 Sediment

After the soils have been flooded and saturated for some period of time (i.e., in excess of a month) and prior to discharge, sediment cores will be collected from five representative locations within the A-2 FEB. Sediment samples will not be collected at a downstream station because it is not feasible to collect sediment cores from the 0 to 4 cm horizon in the downstream canal. Efforts will be made to co-locate interior sediment stations with interior mosquitofish stations.

At each location or site, a minimum of three cores (number of cores in excess of three will be determined by amount of sediment required for analysis) from the 0 to 4 cm horizon are to be collected and composited as a single sediment sample.

To serve as baseline for future comparison, if future conditions warrant follow-up sampling of sediments (i.e., if Tier 2 were triggered), sediment samples will be analyzed for THg, methylmercury (MeHg), moisture content, total organic carbon (TOC), total sulfur (TS), and total iron (TFe). Additionally, these sediment samples will be analyzed and assessed for toxicants other than mercury as discussed below.

2.19.1.3 Water

Although mercury will be monitored and assessed prior to discharge based on tissue concentrations, because of the concern for potential acute toxicity, water will be collected from immediately upstream of the A-2 FEB inflow pump station and outflow gated culvert(s) and analyzed for toxicants other than mercury as discussed below. (Though the A-2 FEB may share some inflow and outflow locations with the A-2 FEB, the mercury/toxicant efforts will not be performed simultaneously given different construction schedules; therefore, none of the monitoring can be shared between the two FEBs.)

Table D.2.10 summarizes the monitoring requirements for Phase 1 - Tier 2: Field Sampling for Initial Startup Monitoring Prior to Discharge.

Table D.2.10: Phase 1 - Tier 2 Initial Startup Monitoring Prior to Discharge

Matrix	Location	Collection Method	Frequency	Parameter(LIST TO BE EDITED)
Mosquitofish	One (1) composite sample consisting of fish collected at multiple locations within A-2 FEB and one (1) composite sample downstream	Net or Trap	One-time	THg Arsenic, dieldrin, copper, and selenium
Sediment	Five (5) stations within A-2 FEB	Sediment Core	One-time	THg, MeHg, Moisture Content, TOC, TS, and TFe Arsenic, atrazine, dieldrin, copper, and selenium
Surface Water	Inflow and Outflow	Grab	One-time	Arsenic, atrazine, dieldrin, copper, and selenium

2.20 Selection of Toxicants Other Than Mercury

The following information sources have been reviewed for data regarding this project: Preliminary results from cultivates soil sampling conducted on A-2 FEB lands in January of 2013. Based on these analytical results, samples will be collected and analyzed for the parameters identified in **Table D.2.11** for each of the specified matrices.

Table D.2.11: Parameter list of toxicants other than mercury to be analyzed in specified matrix. (TO BE EDITED)

Analyze	Surface Water	Sediment	Fish Tissues
arsenic	X	X	X
atrazine	X	X	- *
copper	X	X	X
dieldrin	X	X	X
selenium	X	X	X

* parameter not analyzed

The District shall provide the Department with the results of these analyses as well as the appropriate action levels for comparison. If the following criterion is met for A-2 FEB, the District may initiate flow-through operational and routine compliance monitoring (for details on routine monitoring, see below).

- If ambient mosquitofish do not demonstrate excessive bioaccumulation that exceeds a critical tissue benchmark used to establish SQAGs or in site-specific risk assessments;
- If concentrations in sediments do not exceed an effects-based, numerical sediment quality assessment guideline (SQAGs for sediment dwelling organisms, MacDonald Environmental Sciences Ltd. and USGS, 2003);
- If concentrations in sediments do not exceed an established bio-accumulative based SQAG, if available (MacDonald Environmental Sciences Ltd. and USGS, 2003), a action level reported in the ESA or a level that was determined to be critical in a site-specific risk assessment;
- If water-column concentrations do not exceeded the state water quality standard (WQS) in Chapter 62-302, Florida Administrative Code (F.A.C.)

However, if the above referenced action level is exceeded, the District shall immediately (within 14 days of receiving quality assured data from the laboratory) collect a sample(s) to confirm the exceedance(s). In addition, the District shall consult with the Department to determine the most appropriate course of action and obtain authorization to initiate flow-through operation from A-2 FEB. At a minimum, the course of action will include implementation of Tier 2 Expanded Monitoring and Risk Assessment by the District during initial flow-through operations. The recommended course of action may also include additional measures as determined to be appropriate. When results of expanded monitoring demonstrate concentrations in each operating unit has decreased to acceptable levels (below action levels referenced above), and the concentrations at the downstream site are not significantly elevated above baseline levels, the District shall notify the Department and request that the monitoring revert back to Tier 1 routine monitoring.

2.20.1 Monitoring During Three-Year Stabilization Period

2.20.1.1 Phase 2 - Tier 1: Routine Monitoring During Stabilization Period

2.20.1.2 Water

An unfiltered surface water sample (n = 1) shall be collected in accordance with Chapter 62-160, F.A.C. at the inflow pump station(s) and immediately upstream of the outflow gated culvert(s) (Figure 1) on a quarterly frequency and analyzed for THg and MeHg (sulfate is being monitored under the EFA permit required water quality monitoring program). In addition, flow shall be monitored at the inflow and outflow to allow for load estimation to and from the project (it should be recognized that quarterly sampling would allow for only rough estimation of loads).

Based on the discussion above regarding toxicants other than mercury, a surface water sample will be collected quarterly immediately upstream of the inflow and outflow structures and analyzed for the parameters listed in Table 1 under surface water.

This data set will be assessed to determine if outflow concentrations exceed state water quality standards (WQS), and whether annual outflow loads of analytes are significantly greater than inflow loads, including atmospheric loading; load estimates will include confidence intervals that describe uncertainty in measures of flow and concentration (e.g., field and analytical precision) and resulting from interpolation (note: assessment protocol to be negotiated with permitting authority). Failure to satisfy these assessment measures would trigger Tier 2 Expanded Monitoring and Risk Assessment (see below).

Because of differences in the anticipated time frames under which sedimentary release are thought to occur (i.e., relative to MeHg that may have time lag associated with changes in biogeochemistry and microbial methylation driven by water quality, especially in sandy sediments), monitoring for other toxicants would cease after one year if action levels are not exceeded within that time.Fish Tissues

Because this project is not expected to provide hydrologic conditions or habitat that will support large-bodied fish, sunfish and largemouth bass will not be collected. Mosquitofish will be collected quarterly from multiple locations (Figure 1) within A-2 FEB, physically composited into one (spatially-averaged) sample (to total at least 100 fish), and analyzed for THg and other toxicants listed in Table 1 under fish (note, a single aliquot will be analyzed per composite). Additionally, mosquitofish (to total at least 100 fish) will be collected quarterly from a single station located in the receiving water of the project, immediately downstream of the outfall structure and analyzed for THg and other toxicants.

Table D.2.12 summarizes the monitoring requirements for Phase 2 - Tier 1: Routine Monitoring During Stabilization Period.

Table D.2.12: Phase 2 – Tier 1: Routine Monitoring During Stabilization Period

Matrix	Location	Collection Method	Frequency	Parameter
Surface Water	Two inflow and one outfall structure	Grab	Quarterly	THg, MeHg Arsenic, atrazine, copper, dieldrin, and selenium *
Mosquitofish	One (1) composite sample consisting of fish collected at multiple locations within A-2 FEB and one (1) composite sample downstream of G-13	Net or Trap	Quarterly	THg Arsenic, copper, dieldrin, and selenium *

* Monitoring for toxicants other than mercury will cease after one year if action levels are not exceeded.

Assessment

To detect and minimize any adverse effects as early as possible (and to provide a basis for identifying adaptive management options, if deemed necessary), the results of this monitoring will be assessed based on the criteria and time table described under Phase 2 – Tier 1 in the *Protocol*. Monitoring results will be provided to the Department in accordance with the reporting requirements described below.Phase 2 - Tier 2: Expanded Monitoring and Risk Assessment

In accordance with the *Protocol*, if Tier 1 data exceed the action levels identified under Phase 2 – Tier 2: Expanded Monitoring and Risk Assessment, the District shall notify the Department and after obtaining the Department's concurrence, shall expand monitoring and undertake all necessary steps consistent with the *Protocol*.Operational Monitoring

The monitoring plan and associated data will be re-evaluated on regular basis beginning after year 1 for other toxicants and after year 3 for mercury species to determine if criteria specified in the *Protocol* are being satisfied (following startup of A-2 FEB). Based on that assessment, and with the concurrency of the Department, monitoring and assessment efforts may be reduced (as identified in Phase 3 – Tier 1: Operational Monitoring from Year 4 to Year 9 of the *Protocol*) or eliminated altogether at the project level to be subsumed by regional monitoring (as identified in Phase 3 – Tier 3: Routine Operational Monitoring After Year 9 of the *Protocol*). However, if monitoring reveals anomalous conditions as described under Phase 3 – Tier 2: Expanded Monitoring and Risk Assessment, the District shall expand monitoring and undertake all necessary steps identified under Phase 3 – Tier 2 the *Protocol*.

2.20.2 Phase 3 – Tier 1: Routine Operational Monitoring from Year 4 to Year 9

2.20.2.1 Fish Tissues

Semiannually, mosquitofish will be collected from multiple locations within the A-2 FEB and from single station located in the receiving water of the project (**Figure 2-2**). Specifically, mosquitofish will be collected semiannually from multiple locations within the A-2 FEB, physically composited into one (spatially-averaged) sample (to total at least 100 fish), and analyzed for THg (note, a single aliquot will be analyzed per composite). Additionally, mosquitofish (to total at least 100 fish) will be collected semiannually from a single station located in the receiving water of the project, immediately downstream of the A-2 and analyzed for THg.

This data will then be used to track the following:

- THg levels in individual mosquitofish composite;
- Annual average THg levels in mosquitofish;

Table D.2.13 summarizes the monitoring requirements for Phase 3 – Tier 1: Routine Operational Monitoring from Year 4 to Year 9.

Table D.2.13: Phase 3 – Tier 1: Routine Operational Monitoring from Year 4 to Year 9

Project Code	Matrix	Location	Collection Method	Frequency	Parameter
A2FEB	Mosquitofish	One (1) composite sample consisting of fish collected at multiple locations within A-2 FEB and one (1) composite sample downstream of G-13	Net or Trap	Semiannually	THg

2.20.2.2 Phase 3 - Tier 2: Expanded Monitoring and Risk Assessment

Tier 2 monitoring and assessment is triggered if one of the following action levels is exceeded during operation:

- If annual average THg levels in mosquitofish progressively increased over time (i.e., two or more years) or any (semi-annual) mosquitofish composite exceeds the 90% upper confidence level of the basin-wide annual average or, if basin-specific data are lacking, exceeds the 75^{th} percentile concentration for the period of record for all basins; or

The following steps will be taken if any action level in Tier 2 is triggered:

Step 1: Notify the Department;

Step 2: Resample fish species that triggered Tier 2;

If results of Step 2 (i.e., re-sampling) demonstrate that the anomalous condition was an isolated event, the Department will be notified that the project will revert back and continue with Tier 1 monitoring. Alternatively, if results of Step 2 reveal the anomalous condition was not an isolated event, proceed to Step 3.

Step 3: Expanding monitoring program as follows:

- Increase frequency of mosquitofish collection from semiannually to monthly.
- If Tier 2 was triggered by THg levels in fish at the downstream site, possibly due to excessive loading from the FEB outflow, then quarterly water-column sampling at the outflow station will begin. If necessary (i.e., if loading uncertainty is high), increase frequency of surface water collection to monthly (reducing temporal interpolation), or as appropriate for hydraulic retention time (HRT).
- If Tier 2 was triggered by THg levels in fish within only one of the operating units, further define spatial extent of problem by collecting multiple mosquitofish composites from within the operating unit exhibiting anomalous conditions.
- To evaluate possible trends in mercury methylation rates in sediments (i.e., to determine if methylation rates are increasing or decreasing), replicate sediment cores (0-4 cm) can be collected from the suspected methylation “hot spot” and reference locations within the component (for THg, MeHg, moisture content, total organic carbon (TOC), total sulfur (TS), and total iron (TFe)) over a given period of time (i.e., 2 to 4 months). At these same locations and collection times, collect pore

water samples and analyze for THg, MeHg, and sulfides, or if no acceptable pore water protocol has been developed, then acid-volatile sulfide (AVS) on solids shall be completed.

Projects shown to have (spatially) large or multiple MeHg "hotspots" should consider use of the Everglades Mercury Cycling Model (E-MCM) or comparable model as an assessment tool (i.e., to synthesize results of expanded monitoring).

Step 3 will also include the notification of the Department that anomalous conditions are continuing. The Department and the District may then develop an adaptive management plan using the data generated from the expanded monitoring program. This plan will evaluate the potential risks from continued operation under existing conditions (i.e., through a risk assessment for appropriate ecological receptors). If risk under existing operational conditions is deemed acceptable, then project monitoring would continue under a modified Tier 2 scheme to monitor exposure. On the other hand, if risk under existing operational conditions is deemed unacceptable, then the adaptive management plan would then proceed to determine potential remedial actions to (1) reduce exposure and risk (e.g., signage for human health concerns[1], reduce fish populations, reduce forage habitat suitability) and (2) affect mercury biogeochemistry to reduce net methylation (e.g., modify hydroperiod or stage, water quality).

In developing this adaptive management plan, the Department may conduct a publicly noticed workshop to solicit comments from the District, the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, the National Park Service, the Florida Fish and Wildlife Conservation Commission, and other interested persons.

The next step would then be to carry out such remedial or corrective action. If the remedial or corrective action is demonstrated to be successful, then the project would revert back to Tier 1 monitoring. Alternatively, if monitoring data indicate that the remedial action was unsuccessful in reducing fish tissue THg concentrations or downstream THg loading, the Department and the District would then initiate a peer-reviewed, scientific assessment of the benefits and risks of the project.

2.20.2.3 Phase 3 - Tier 3: Termination of Monitoring After Year 9

If fishes collected under Phase 3 - Tier 1 have not exceeded action levels by year 9, project-specific monitoring would be discontinued; future assessments would be based on regional monitoring.Annual Mercury Monitoring Report

The District shall notify the Department immediately if monitoring data indicate that any of the action levels are exceeded. In addition, the District shall submit an annual report to be incorporated into the SFER and submitted to the Department no later than March 1st of each year. The annual report shall summarize the most recent results of the monitoring as defined above and compares them with the cumulative results from previous years. This report shall also evaluate assessment performance.

[1] Note that assessment of potential human health impacts and corrective actions (i.e., signage) will require the involvement of the Florida Department of Health)

2.20.3 **Adaptive Management Strategy**

It is the intent that this monitoring plan will be carried out within the context of an adaptive management strategy that will allow for appropriate changes based on new, better understanding of mercury cycling, fate and transport as conveyed in the guidance contained in the *Protocol*.

PART 3. CEPP Hydrometeorological Monitoring Plan

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3.0 HYDROMETEOROLOGICAL MONITORING

3.1 Data quality objectives

Developing Data Quality Objectives (DQOs) is an integral and important part of a systematic planning process that is designed to ensure that the final results can be used for the purpose for which the data were generated. This systematic planning process for purposes of these discussions on environmental data quality is the quality system that each organization must develop, implement and evaluate on a continuing basis.

The data will be used to measure project performance, water quality-related goals and objectives and to comply with monitoring requirements of an operational permit. The DQOs to be considered include accuracy, precision, sampling frequency, availability, completeness, reporting frequency, and timeliness. These are addressed in CERP's *Quality Assurance Systems Requirements*, Chapter 6, Table 6.1, dated 7 December 2010. The DQOs are further outlined in Section 3.1.1 of this document.

3.1.1 Monitoring Data Elements/Indicators

Hydrometeorological and hydraulic monitoring will collect, at a minimum, groundwater and/or surface water stages measured at each of the new structures; gate openings at gated structures; and pump RPMs at pump stations (to be used in calculating flows). Specific gages are described in **Table D.3.1**, which provides summary information on the gages, parameters, sensor types, collection frequency, and pertinent notes to ensure the hydrometeorological monitoring is completed as needed. Data will be recorded at the noted structure locations within the project area, recorded and transmitted based on existing network coverage as possible. The hydrologic and meteorological data collection equipment used for this project would be installed as part of the construction contract or a separate contract with construction funding. Hydrometeorological parameters such as surface and ground water stages require accurate estimates of the water elevation height compared to a known reference. All new surface and ground water monitoring installations will be surveyed to a first order accuracy using the nearest geodetic benchmark. Reference elevations will be reported in both the NAVD 88 and NGVD 29 datums. Several of the structures are located within a close proximity to each other and/or existing gages, and therefore a reduction in the total number of new gages that are needed can be made. The particular gages that may be eliminated due to redundancy are noted in the table. A map of the structures with their proposed gaging requirements is presented below the table, in **Figure D.3.1**. Other gages used in the operations of the system as a whole (such as water levels in the Water Conservation Areas) are not shown on the map.

The USACE Jacksonville District receives data from various sensors and data collection platforms to monitor surface water flows and levels. Automated timed processes provide provisional near-real-time data required for water management operations. Additional data are also received through an interagency data exchange program among the SFWMD, the USGS, and ENP.

Table D.3.1: CEPP Gaging Needs. Hydrometeorological Monitoring

This table lists the necessary gaging parameters to be collected as part of CEPP, which are in addition to current monitoring stations that will be leveraged for CEPP. The headwater and tailwater stage gages located directly upstream and downstream of the structures, respectively, along with the gate openings, are used in computing flows through structures, as well as assisting in determining the operations. The 15-minute frequency is the USACE required standard for these parameters. Breakpoint data for a pump is collected when changes to the RPMs are made, up to a frequency of 1-minute. The shaded table rows are for gages that may be unnecessary due to the proximity of other gages; potential alternate gages are listed in the notes.

Gage	Parameter	Sensor Type	Frequency	Notes
S-623 HW	Stage, headwater	SDI encoder	15-minute	Located near structure, platform installation
S-623 TW	Stage, tailwater			Use G-372 HW gage
S-623 Gate	Gate position	Pos. Indicator	15-minute	Located on the gate
S-624 HW	Stage, headwater	SDI encoder	15-minute	Located near structure, platform installation
S-624 TW	Stage, tailwater	SDI encoder	15-minute	Located near structure, platform installation
S-624 Gate	Gate position	Pos. Indicator	15-minute	Located on the gate
S-625 HW	Stage, headwater	SDI encoder	15-minute	Located near structure, platform installation
S-625 TW	Stage, tailwater	SDI encoder	15-minute	Located near structure, platform installation
S-625 Gate	Gate position	Pos. Indicator	15-minute	Located on the gate
S-626 HW	Stage, headwater	SDI encoder	15-minute	Located near structure, platform installation
S-636 TW	Stage, tailwater	SDI encoder	15-minute	Located near structure, platform installation
S-626 Pump	Pump RPMs	Inc. in controls	Breakpoint	Located at pump
S-627 HW	Stage, headwater			Use S-628 HW gage
S-627 TW	Stage, tailwater			Use S-628 TW gage
S-628 HW	Stage, headwater	SDI encoder	15-minute	Located near structure, platform installation
S-628 TW	Stage, tailwater	SDI encoder	15-minute	Located near structure, platform installation
S-628 Gate	Gate position	Pos. Indicator	15-minute	Located on the gate
S-620 HW	Stage, headwater	SDI encoder	15-minute	Located near structure, platform installation
S-620 TW	Stage, tailwater			Use S-7 HW gage
S-620 Gate	Gate position	Pos. Indicator	15-minute	Located on the gate
S-621 HW	Stage, headwater	SDI encoder	15-minute	Located near structure, platform installation
S-621 TW	Stage, tailwater	SDI encoder	15-minute	Located near structure, platform installation
S-621 Gate	Gate position	Pos. Indicator	15-minute	Located on the gate
S-622 HW	Stage, headwater	SDI encoder	15-minute	Located near structure, platform installation
S-622 TW	Stage, tailwater	SDI encoder	15-minute	Located near structure, platform installation
S-622 Gate	Gate position	Pos. Indicator	15-minute	Located on the gate
S-8A HW	Stage, headwater	SDI encoder	15-minute	Located near structure, platform installation
S-8A TW	Stage, tailwater	SDI encoder	15-minute	Located near structure, platform installation
S-8A Gate	Gate position	Pos. Indicator	15-minute	Located on the gate
S-630 HW	Stage, headwater	SDI encoder	15-minute	Located near structure, platform installation
S-630 TW	Stage, tailwater	SDI encoder	15-minute	Located near structure, platform installation
S-630 Pump	Pump RPMs	Inc. in controls	Breakpoint	Located at pump
S-333N HW	Stage, headwater			Use existing S-333 HW gage
S-333N TW	Stage, tailwater			Use existing S-333 TW gage
S-333N Gate	Gate position	Pos. Indicator	15-minute	Located on the gate
S-356 HW	Stage, headwater			Use existing S-356 HW gage
S-356 TW	Stage, tailwater			Use existing S-356 TW gage
S-356 Pump	Pump RPMs	Inc. in controls	Breakpoint	Located at pump
S-631 HW	Stage, headwater	SDI encoder	15-minute	Located near structure, platform installation
S-631 TW	Stage, tailwater	SDI encoder	15-minute	Located near structure, platform installation
S-631 Gate	Gate position	Pos. Indicator	15-minute	Located on the gate
S-632 HW	Stage, headwater	SDI encoder	15-minute	Located near structure, platform installation
S-632 TW	Stage, tailwater	SDI encoder	15-minute	Located near structure, platform installation
S-632 Gate	Gate position	Pos. Indicator	15-minute	Located on the gate
S-633 HW	Stage, headwater	SDI encoder	15-minute	Located near structure, platform installation
S-633 TW	Stage, tailwater	SDI encoder	15-minute	Located near structure, platform installation
S-633 Gate	Gate position	Pos. Indicator	15-minute	Located on the gate
S-355W HW	Stage, headwater	SDI encoder	15-minute	Located near structure, platform installation
S-355W TW	Stage, tailwater	SDI encoder	15-minute	Located near structure, platform installation
S-355W Gate	Gate position	Pos. Indicator	15-minute	Located on the gate

Figure D.3.1: Map of Structures with Proposed Gages

3.1.2 **Procedures and Methods**

Measurements will be recorded in the manner outlined in CERP's *Quality Assurance Systems Requirements*, Chapter 6, Table 6.1, dated 7 December 2010.

To summarize, surface water stages will be measured using an SDI encoder at each monitoring location. The accuracy required is ±0.02 feet for critical sites and ±0.03 feet for non-critical site. The reported resolution will be 0.01 feet and the instrument range will be 0 20 feet. The precision will be ±0.01 feet. The sampling frequency will be 15 minutes, at 0, 15, 30, and 45 minutes past each hour (e.g. at 1500 hrs, 1515 hrs, 1530 hrs, etc).

Groundwater stages will be measured using an SDI encoder at each monitoring location. The accuracy required is ±0.03 feet. The reported resolution will be 0.01 feet and the instrument range will be 0 30 feet. The precision will be ±0.01 feet. The sampling frequency will be 15 minutes.

Rainfall will be measured with an accuracy of ±0.01 inches. The reported resolution will be 0.01 inches and the precision will be ±0.01 inches. The sampling frequency will be 15 minutes.

Gate positions will be measured using gate position indicators with an accuracy of ±0.05 feet, a reported resolution of 0.01 feet, and a gate position range of either 0-75 inches or 0-550 inches. The precision required is ±0.02% full stroke. The reporting frequency will be 15 minutes.

Pump RPMs will be measured with an accuracy of ±25 RPM and a reported resolution of 1 RPM. The pump RPM range will be 0-3,000 RPMs. The reporting frequency will be 1-360 samples per hour.

Computed flows will have an accuracy uncertainty limit of 95% C.I. The accuracy will be ±10% for inland spillways, ±15% for culverts, and ±15% for pumps. The velocity instrumentation will have a precision of ±0.01 feet/second. The reporting frequency will be 15 minutes.

The hydrologic and meteorological data collection instruments utilized for this project will be installed as part of the construction contract or under separate contract. Water stage measuring devices will be affixed to a platform in a manner to discourage vandalism and natural or unnatural intrusions (inclement weather, animals, etc). Water surface elevation measuring devices will use SDI encoders for measuring values. Gate positions will be measured using gate position indicators. Flow calculation equations that are used to compute flow on site with certain instrument types, such as a programmable data logger, will be developed under the supervision of the sponsoring agencies hydrology and hydraulics monitoring units during the execution of this monitoring plan.

3.2 Rationale for indicator selection

The indicators selected for inclusion are required under CERP's *Quality Assurance Systems Requirements*, Chapter 6, Table 6.1, dated 7 December 2010. The headwater and tailwater values are used, along with gate openings or pump RPMs, to determine the flow of water through the structure.

3.3 Sampling frequency and duration

The sampling frequency and duration is governed by CERP's *Quality Assurance Systems Requirements*, Chapter 6, Table 6.1, dated 7 December 2010.

Surface water stages recording frequency will be 15 minutes, at 0, 15, 30, and 45 minutes past each hour (e.g. at 1500 hrs, 1515 hrs, 1530 hrs, etc).

Groundwater stages recording frequency will be 15 minutes.

Rainfall recording frequency will be 15 minutes.

Gate positions recording frequency will be 15 minutes.

Pump RPMs recording frequency will be by break point, with a minimum of one (1) recording per hour up to 360 recordings per hour.

Computed flows computing frequency will be 15 minutes.

3.4 Assessment Process and Decision Criteria (triggers and thresholds)

Trigger elevations for surface water will take into consideration the design headwater and tailwater at the gages' respective structures to ensure that design limits are not reached. In addition, the decision criteria will be further refined as the operations of CEPP are developed.

3.4.1 Data Collection

3.4.2 Sample/Data Collection Standards and Ethics

No samples will be collected for hydrometeorological monitoring. Data will be collected following the required standards as described in this document.

3.4.3 Sample Submission

No samples will be collected for hydrometeorological monitoring.

3.4.4 Chain of Custody

No samples will be collected for hydrometeorological monitoring.

3.4.5 Quality Control Samples

No samples will be collected for hydrometeorological monitoring.

3.4.6 Data Validation

The Corps data validation process is subject to ER 1110-2-8155, *Hydrometeorological Data Management and Archiving*, dated 31 July 1996 and ER 1110-2-249, *Management of Water Control Data Systems*, dated 31 August 1994. The Corps data validation methods may be accomplished by automated or manual means. This process may include estimating values for missing or erroneous data.

The SFWMD procedures are described in their *2008 South Florida Environmental Report, Appendix 2-1: Hydrological Monitoring Network of the South Florida Water Management District.* The following paragraph is from a relevant section of that document.

"Several standard operating procedures (SOPs) were developed for data processing by the District…Many of these procedures and processes are automated. The Data Collection/Validation Preprocessing System (DCVP) database provides for the storage and extraction of preliminary time-series data for further inspection. Once data is extracted from DCVP, it is subjected to an initial QA/QC check in order to ascertain or improve data quality. This is accomplished through the use of the Graphical Verification Analysis (GVA) Program, a software tool which provides analysts with a graphical user interface in which to plot, edit, and apply quality tags and comments to data. The GVA application is used for the validation of the data. Once data has undergone analysis in GVA, it is uploaded into the DBHYDRO database, finalizing the preprocessing stage…"

3.4.7 **Raw Data**

Data collected by the SFWMD will be kept as raw archive files. The adjusted (QA/QCed) data will be stored as processed archive files. Data collected by the Corps is maintained in Oracle databases and further computations are applied to generate addition databases of computed data.

3.4.8 **Data Processing**

The Corps data validation process is subject to ER 1110-2-8155, *Hydrometeorological Data Management and Archiving*, dated 31 July 1996 and ER 1110-2-249, *Management of Water Control Data Systems*, dated 31 August 1994.

The SFWMD procedures are described in their *2008 South Florida Environmental Report, Appendix 2-1: Hydrological Monitoring Network of the South Florida Water Management District.*

Data processing should be approached with the same high accuracy standards for all sites/stations regardless of mandate or permit conditions. Flow and meteorological data must be summarized or derived through review, analysis, and interpretation before they can be placed in any meaningful context, then published. Data processing involves multiple steps: (1) data retrieval, (2) data review, (3) data verification and validation, (4) data analysis of raw time-series data to ensure data quality in support of environmental monitoring and assessment activities, (5) interpretation of analysis, and (6) archival.

3.4.9 **Data Storage and Archiving**

Data collected or obtained by the Corps will be stored and archived in accordance with ER 1110-2-8155, *Hydrometeorological Data Management and Archiving*, dated 31 July 1996. The Corps maintains Oracle databases where all collected and computed Water Management data is stored/archived.

For the SFWMD, after the data validation process (generally with one week), all data are archived in a SFWMD database (DBHYDRO) and maintained so that end users can retrieve and review all information relative to a sampling event. If data are not suitable for DBHydro, they will be entered into the CERP Integrated Database (CID) on CERPZone through the Morpho interface. Field notes are maintained on an internal server either by scanning actual field note pages as PDFs (Portable Document Format) or by uploading narratives from field computers as CSVs (Comma Separated Values). All analytical data and field conditions are sent to a database designated by the sponsors for long-term storage and retrieval. The sampling agency or contractor maintains records of field notes and copies of all records relative to the chain of custody and analytical data. It is the responsibility of each agency or contractor to maintain both current and historical method and operating procedures so that at any given time the conditions that were applied to a sampling event can be evaluated. For any contracted work, original documents are to be provided to the SFWMD by the project completion date.

3.5 Documentation

For all documents, the following standards should apply:

- Print text, do not use cursive handwriting.
- Dates should be recorded as MM/DD/YYYY.
- Time should be recorded in 24-hour format using local time.
- Logs and notes should be recorded on site and at the time of collection.
- Entries are to be made in waterproof ink.
- Samplers should be properly trained.

3.5.1 Field Notes

No field samples will be collected for hydrometeorological monitoring. Relevant field observations will be noted in a bound waterproof notebook that is project specific. The following information will be entered into the field notes: project name, frequency, trip type, date, collectors, responsibilities, weather, preservation/acids, labs submitted to, sample ID, site ID, time collected, and sample type. Additional comments on observations, equipment cleaning, maintenance, and calibration will also be recorded.

3.5.2 Field Instrument Calibration Documentation

Records of field instrument calibration will be kept and SFWMD or Corps SOPs for calibration will be followed.

3.5.3 Corrections

Corrections to header sheets, field notes, or calibration sheets will only be made by staff who participated in the production of the document. Changes will be made by striking through the error, writing the correction, initialing and dating the change. On occasion, a detailed explanation of the error may be required.

3.6 Quality Assurance and Quality Control

3.6.1 System for assessing data quality attributes

The standards as set forth under the Corps and the SFWMD's respective requirements will be adhered to and followed. These are described and/or referenced under Section 2.3 of this document.

3.6.2 Data quality qualifiers

The data quality standards are outline in Section 2.2 of this document.

3.6.3 Field Audits

The data quality standards for hydrometeorological data are determined under the Corps and SFWMD's respective guidances and will be followed.

3.7 Data Analyses and Records Management

The Corps process is subject to ER 1110 2 8155, Hydrometeorological Data Management and Archiving, dated 31 July 1996 and ER 1110 2 249, Management of Water Control Data Systems, dated 31 August 1994.

The SFWMD procedures are described in their 2008 South Florida Environmental Report, Appendix 2 1: Hydrological Monitoring Network of the South Florida Water Management District.

Please refer to Section 2.3 of this document for further information.

3.7.1 Data Quality Evaluation and Assessment

The data quality standards for hydrometeorological data are determined under the Corps and SFWMD's respective guidances and will be followed.

3.8 Adaptive Management Considerations

Where possible, CEPP hydrometeorological data will support adaptive management by contributing data needed to address CEPP uncertainties and future project adjustments. The adaptive management strategies that will leverage hydrometeorological data include but are not limited to optimizing water deliveries from FEB-2 (AM uncertainty ID#4), flows to improve soil conditions and restore ridge and slough areas south of the hydropattern restoration feature and in the Blue Shanty flowway (AM uncertainty ID#5, 6, 73), incremental restoration in WCA 3B (AM uncertainty ID#76, 77), and deliveries south to Everglades National Park and the Lower East Coast (AM uncertainty ID#32, 35,61, 62, 63,).

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PART 4. CEPP Ecological Monitoring Plan

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4.0 INTRODUCTION TO THE CEPP ECOLOGICAL MONITORING PLAN

The Greater Everglades ecosystem has been significantly altered by human activities. Historically, freshwater flowed in a north-south direction from Lake Okeechobee to Florida Bay. This pattern has been altered by regional drainage of freshwater flow patterns and volumes that has resulted in the loss of ridge-slough pattern in the freshwater wetlands and an inland migration of saline conditions in both the groundwater and surface waters such that the expansion of moderate to high salinity zones have diminished the spatial extent of freshwater wetland habitats, and have allowed the landward expansion of saltwater and mangrove wetlands. Prior to the hydrologic changes described above, freshwater and mangrove marshes provide important habitat for wetland species and are indicators of healthy Everglades and coastal wetlands. Among other things, the hydrologic change to the system has caused a significant degradation of both the freshwater and the estuarine environments that has resulted in the loss of or reduction in populations of important estuarine species that once were abundant in the area, including Spoonbills, Wood Storks, and Alligators among other wildlife. Efforts of Central Everglades Planning Project (CEPP) focus on re-directing flow to re-establish more natural overland flow regimes that will provide appropriate hydropatterns and salinity regimes to re-establish and maintain key habitats within the Greater Everglades, including the Everglades National Park and Florida Bay.

The primary objective of the CEPP Ecological Monitoring Plan (CEPP-EMP) is to identify the monitoring necessary to inform decision-makers, CEPP partner agencies, and the public on achieving restoration success. In other words, to specify what monitoring is necessary to measure and detect the benefits of restoring patterns of freshwater flow, velocity, and water quality in the Central Everglades, Northern Estuaries, and Southern Coastal Systems, per the CEPP project objectives. This monitoring will be leveraged as much as possible to contribute to CEPP adaptive management. However, given the scope and scale of CEPP, in this project the ecological monitoring and the monitoring identified in the CEPP Adaptive Management Plan (Annex D, Part 1) are not one-and-the-same, because the CEPP-EMP focuses on CEPP's success at meeting *project objectives* (per WRDA 2007 guidance) while the monitoring specified in the Adaptive Management Plan focuses on addressing *project uncertainties* (per WRDA 2007 guidance) that may be more specific in their location and/or scale than the overall project objectives. Also, the Adaptive Management Plan focuses on project tweaks and adjustments that could be made relatively easily to improve project performance, and the monitoring described in that plan will inform such adjustments, whereas monitoring for overall project success in a project as large as CEPP may not provide the level of detail needed to answer the specific adaptive management questions. In summary, since the project objectives and the uncertainties are not redundant then neither is the monitoring, but the CEPP-EMP and CEPP AM Plan have been designed to inform each other as much as possible and it is encouraged that any future refinements of the Plans include continual improvements of the streamlining.

The CEPP-EMP will monitor ecosystem responses to changes in hydroperiod depth, duration, and velocity within the Central Everglades that are expected to provide ecological conditions suitable for expanded and intensified wildlife utilization through improvements in wetland habitat functional quality, and improvements in native plant and animal species diversity and abundance. Due to the uncertainties associated with any effort to restore the Greater Everglades, including the ENP and associated coastal communities, the performance targets and the measures of success can only be broadly stated. Nevertheless, these targets and measures need definition to design a monitoring program that is focused and efficient, thereby ensuring that it will provide the kind of information necessary to measure restoration success. The CEPP-EMP will be updated, at the latest, during CEPP pre-construction engineering and design to reflect more specific targets and measures of restoration success.

This second objective of the CEPP-EMP is to contain the monitoring and associated costs required under the U.S. Fish and Wildlife Biological Opinion and other agency permits that are needed to protect and conserve natural resources. The CEPP-EMP will be updated accordingly when the Biological Opinion is received and FDEP and other agency permits are obtained.

The CEPP-EMP will be closely coordinated with the CERP RECOVER Monitoring and Assessment Plan (MAP) to ensure that measures and targets selected by the project teams are consistent with system-wide measures and to avoid duplication of efforts. Furthermore, the CEPP-EMP will ensure temporal and spatial coverage of monitoring parameters that are appropriate to detect changes at the project level. The EMP will fill gaps in the MAP monitoring parameters to address CEPP-specific needs by adding additional project-level parameters not included in the MAP. Thus, the CEPP-EMP will cover CEPP regions within the Greater Everglades with greater spatial and temporal resolution to detect ecological changes resulting from project-level implementation in order to evaluate project success.

The Everglades are periodically inundated or dried out, an environmental characteristic that provides a challenging environment for the plant and aquatic animal communities. Furthermore, measuring restoration and monitoring success are particularly challenging because the Everglades is inherently dynamic in space and time. Monitoring targets provided in this EMP are limited to the scope of CEPP, i.e., they are not full restoration targets for the Everglades restoration program but instead they are attributes that relate directly to the restoration that CEPP could provide and that can be measured in the time-frame specified in WRDA 2007 and USACE cost-sharing guidance (monitoring for ecological success can be cost-shared for up to 10 years only). Due to ever-increasing understanding of the complex Everglades and associated estuaries, and more detailed information that will be available during CEPP's design phase, the CEPP success monitoring targets may need to be refined during CEPP's design phase.

4.1 Structure of the CEPP Ecological Monitoring Plan

For each CEPP project objective, monitoring has been identified to measure progress toward success of meeting the objective. Table 1 summarizes the (1) monitoring attributes, (2) monitoring methodology and frequency, (3) monitoring cost estimates, (4) CEPP monitoring locations, (5) Current MAP monitoring component (6) Current monitoring by other agencies/universities and (7) Performance Measures and ecological indicators. The Ecological Monitoring Plan's main goal is to detect the expected improvements from CEPP features and operations.

The Greater Everglades portion of the CEPP-EMP focuses on three main geographic regions: 1) the northern WCA-3A Hydropattern Restoration Feature, 2) Blue Shanty Flowway, and 3) Shark River Slough, which includes freshwater and coastal wetlands (**Figure D.4.1**). The ecological monitoring will include environmental parameters associated with hydrology (flow, stage and hydroperiod), soil parameters associated with soil accretion and subsidence, wetland plant community, and wildlife.

4.2 Objective 1

Restore seasonal hydroperiods and freshwater distribution to support a natural mosaic of wetland and upland habitat in the Everglades System (Table D.4.1A)

Spatial patterning and topographic relief of the ridge-slough-tree island landscape are directly related water flow, including the timing, velocity, hydroperiod, and distribution of sheet flow, therefore the spatial patterning has been lost in most of the Greater Everglades with drainage and compartmentalization. At the landscape level, the loss of elongated patterns of ridges, sloughs, and tree islands in the direction of the flow is attributed to disrupted sheet flow and changes in water depth. Monitoring for this objective will test the hypothesis that resumption of sheet flow and water depth patterns will reverse the degradation of the ridge-slough-tree island landscape. Similarly, quantification of subsidence, accretion, and sediment transport are required to understand the role that flow direction, velocity, and water depth play in restoring and maintaining the ridge-slough-tree island landscape. Thus, for this objective, two attributes will be monitored: a) soil elevation and accretion along the ridge-slough-tree islands landscape and b) vegetation change along hydrologic gradients. Related hydrologic data will be leveraged from existing monitoring networks and the CEPP Hydrometeorological Monitoring Plan (Annex D, Part 3). The monitoring methodology includes the establishment of permanent transects and plots within 2 x 5 km cells denominated GRTS (Generalized Random-Tesselation Stratified). The placement of transects and plots, and specific measurement methodology, will be coordinated with existing GRTS locations in the Everglades that are part of the RECOVER MAP to avoid redundancy and leverage the existing program. This approach provides spatial balance to make better inferences about gradient changes at the landscape level and assumes the existing GRTS monitoring will continue for at least the time needed for CERP. The detailed field methodology to accomplish this objective will be described in more detail once CEPP is authorized.

4.3 Objective 2

Improve sheet flow patterns and surface water depths and durations in the Everglades system in order to reduce soil subsidence, frequency of damaging fires, and decline of tree islands and decrease salt water intrusion (Table D.4.1B)

This objective has two main components, one is associated with the effect of muck fire events on soil oxidation and subsidence, and the other component is linked to the change in freshwater delivery to coastal areas that has disrupted salinity patterns throughout Florida Bay leading to an overall increase in salt water intrusion along the coastal wetlands that has promoted the encroachment of mangrove plant community into the freshwater wetlands. Monitoring for this objective will test the hypothesis that both organic soil loss and accumulation are in equilibrium as a function of sheet flow and water depth patterns. Similarly, it is expected that improvement of water sheet flow will help to decrease the rate of mangrove expansion into the freshwater wetlands. To accomplish this objective, several attributes will be monitored including soil accretion and soil elevation in mangrove communities, porewater and soil salinity, and biological indicators such as algae and pink shrimp. The monitoring methodology includes the use of Sediment Elevation Tables (SETs) to measure soil accretion and subsidence, establishing transects to measure soil salinity, porewater and soil resistivity. The placement of SETs, and specific measurement methodology, will be coordinated with existing SETs locations in the Everglades that have been part of the RECOVER MAP to avoid redundancy and leverage existing data for comparison. To estimate spatial changes in the ridge-slough-tree island landscape and mangrove migration into the freshwater wetlands, vegetation mapping will be conducted, also in coordination with existing programs for efficiency. The detailed field methodology to accomplish this objective will be described in more detail once CEPP is authorized.

4.4 Objective 3

Reduce high volume discharges from Lake Okeechobee to improve the quality of oyster and SAV habitat in the Northern Estuaries (NE) (Table D.4.1C)

Using CEPP planning model output, areas have been identified within the northern estuaries where the most change is expected due to CEPP. In these areas salinity conditions will improve the habitat for oysters and SAV, which will be the attributes to measure for project success in meeting Objective 3. In addition, these areas present a clear opportunity for adaptive management because the monitoring data will readily inform potential project adjustments. Therefore, monitoring for Objective 3 is an example of overlapping monitoring needs for the CEPP-EMP and for the CEPP AM Plan. In the Adaptive Management Plan more detail is provided about the potential management actions that could be taken in response to the data. See the Adaptive Management Plan section on the northern estuaries.

4.5 Objective 4

Reduce water loss out of the natural system to promote appropriate dry season recession rates for wildlife utilization (Table D.4.1D)

Nesting wading birds are an iconic symbol of Everglades health and restoration, and there is relatively extensive knowledge about their habitat needs in the Everglades due to efforts of RECOVER, ENP, and other organizations. Successful nesting of wading birds requires habitat conditions, including wet season prey production and dry season prey availability, which depend on hydroperiods and well-timed water level recession rates. Over the past years a decrease in wading birds has been observed; this decrease of wading birds nesting colonies in the Greater Everglades including the ENP is attributed to declines in wet season prey production and dry season prey availability. Monitoring for this objective will test the hypothesis that restoration of multi-year hydroperiods in historically appropriate places in the Everglades will result in increased density of aquatic fauna and large fish. Attributes associated with this objective include monitoring aquatic prey populations during the wet season and dry season, and monitoring wading bird nesting success. Hydrologic data that indicate recession rates will be pulled from existing monitoring networks. Field methodology includes throw traps along designed transects established within GRTS cells. Since RECOVER is already monitoring these attributes in the Greater Everglades, their monitoring will be leveraged and the CEPP-EMP will only establish a monitor network in the coastal wetlands. The ability to leverage existing monitoring programs for efficiency assumes the existing monitoring will continue for at least the time needed for CERP. More detailed field methodology will be described once CEPP is authorized.

4.6 Objective 5

Restore more natural water level responses to rainfall to promote plant and animal diversity and habitat function (Table D.4.1E)

Florida's two native species of crocodilians, the American alligator and the American crocodile are important indicators of the health of the Everglades ecosystem because they are linked to two key aspects of the ecology of the Everglades: 1) crocodilians are directly dependent on prey density, especially aquatic and semi-aquatic organisms, and thus they provide a surrogate for status of many other species, and 2) alligators create “alligator holes” across the landscape that have proven to be a keystone feature of Everglades habitat due to the topographic relief that they provide. The alligator holes provide drier and wetter conditions for plants and animals that otherwise would not be able to survive. Monitoring for this objective will test the hypothesis that more natural hydrological patterns with drydowns no more frequent than once every 3-5 years will improve both alligator body condition and relative density of alligators. As part of this objective several biological attributes will be monitored including alligator-crocodiles density in the landscape, and their body condition. This monitoring compliments the bird nesting success monitoring to increase the ability to draw conclusions from both programs. Field methodology includes aerial transects as well as ground surveys that will be coordinated with past and existing crocodilian monitoring efforts for efficiency and comparisons. The detailed field methodology to accomplish this objective will be based on the past and existing methodologies, and will be described in more detail once CEPP is authorized.

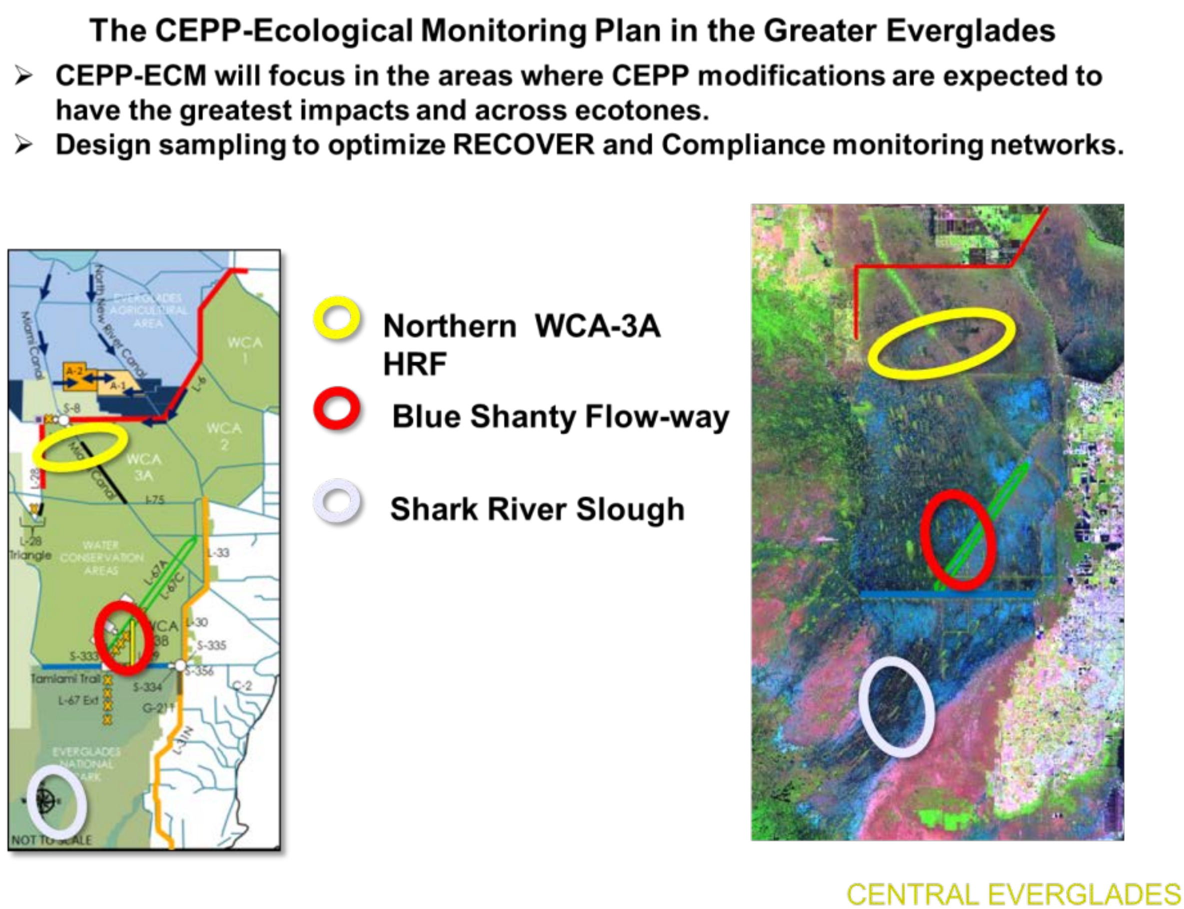

Figure D.4.1: The Greater Everglades, showing the regions where the most hydrological alterations are expected. The Northern WCA-3A, Blue Shanty Flow-way, and Shark River Slough regions are the focus of the Ecological Monitoring Plan (EMP).

Table D.4.1 (A, B, C, D, E): Table identifies CEPP objectives, associated monitoring need related to achieving CEPP project success, monitoring methodology, number of sampling transects and frequency, estimated annual CEPP project cost, monitoring location, current monitoring available from other agencies and RECOVER and their monitoring costs (in some cases there is very little or no CEPP project cost because existing monitoring covers the costs), and associated performance measures or stoplight indicator (method of communicating ecological indicator status as described in the South Florida Ecosystem Restoration Science Coordination Group Stoplight Indicator Report) for context.

A

CEPP Objective	CEPP Monitoring attributes	Monitoring Methodology	Number of Transects / Plots per GRT's	Monitoring Frequency	Estimated Annual Cost	Specific CEPP Monitoring Locations	Current Monitoring (OTHER)	Current Monitoring (RECOVER/CERP)	Current Monitoring Annual Cost (RECOVER/CERP)	Performance Measures / Ecological Indicators	Monitoring Targets
Restore seasonal hydroperiods and freshwater distribution to support a natural mosaic of wetland and upland habitat in the Everglades System	Natural Mosaic of Wetlands: Ridge-Slough-Tree Islands Soil Elevation Pattern	Establish Permanent Transects to Measure Wetland Soil Elevation Pattern	Establish 2 GRTS panel in NE-WCA3A, WCA-3B, and 3 panels in NE-SRS. Five Transects within each GRTS panel	Each Transect Every Year	$100,000	NE-WCA3A,WCA-3B, NE-SRS	a) Daily, seasonal, annual hydroperiods (EDEN. SFWMD, ENP). b) Water Distribution (EDEN, SFWMD, ENP). c) Wetland Vegetation Mapping (RECOVER/MAP)	Landscape Pattern Ridge-Slough-Tree Island in GE	$96,276.00	Slough vegetation performance measure, related to tree island viability and restoration	Bi-Modal Ridge and Slough Patterning
		Comprehensive soil elevation survey: 30 new benchmarks	Synoptic Survey	First three years of CEPP for a Total of $300K	$30,000	NW-WCA3A, NE-WCA3A,Central WCA-3A,WCA-3B, NE-SRS and ENP					
	Vegetation change along hydrologic gradients- from slough to marl prairies, mangroves, and other adjacent habitats	Establish three GRTS panels	Three Transects per GRTS panel	Each Transect Every Year		NE-SRS, ENP	a) Daily, seasonal, annual hydroperiods (EDEN. SFWMD, ENP). b) Water Distribution (EDEN, SFWMD, ENP). c) Wetland Vegetation Mapping (RECOVER/MAP)	Marl-Praire Slough Gradients (Shark River Slough), Florida Bay SAV monitoring (FHAP)	$200,000	Slough vegetation performance measure, related to ELVes, marl prairie assessment tools	SAV % Cover 50-75; SAV Biomass 100-200 g m^{-2}
		Vegetation in plots along coastal gradient transects	Three Transects from SRS to estuaries; five transects from Taylor Slough to Florida Bay	Each Transect Every Year		ENP					

Continued on next page.

B

CEPP Objective	CEPP Monitoring attributes	Monitoring Methodology	Number of Transects / Plots per GERT's	Monitoring Frequency	Estimated Annual Cost	Specific CEPP Monitoring Locations	Current Monitoring (OTHER)	Current Monitoring (RECOVER/CERP)	Current Monitoring Annual Cost (RECOVER/CERP)	Performance Measures / Ecological Indicators	Monitoring Targets
Improve sheet flow patterns and surface water depths and durations in the Everglades System in order to reduce soil subsidence, frequency of damaging fires, and decline of tree islands and decrease of salt intrusion (relates to uncertainties 64)	Soil Elevation and Accretion Rates on Tree Islands and Mangrove Forests	Sediment Elevation Tables (SET's)	Three Plots within Ten Tree Island and Eight Mangrove sites	Annual	$160,000	NW-WCA3A, NE-WCA3A,Central WCA-3A,WCA-3B, NE-SRS, ENP Mangrove Forests	Soil Elevation and Accretion in Four Tree Islands and Four mangrove Sites in Taylor River-McCormick Creek-Trout Creek-Highway Creek (SFWMD)	No On-going Monitoring	$0	Soil accretion	2-4 mm yr^{-1} Accretion rates
	Saltwater Intrusion and nearshore-wetland salinity	Stage, Flow and Saninity: Porewater, Shallow Wells and Belowground Resistivity; nearshore Florida Bay & Whitewater Bay surface water	Three Transects within Shark River and Five transects within Taylor River	Five locations within each transect. Every 4 Months		ENP Shark River and Taylor Slough (White Zone)	Nearshore Florida Bay and Whitewater Bay surface water platforms (ENP Marine Monitoring)	No On-going Monitoring	$0	Florida Bay salinity Performance Measure	Florida Bay salinity range 25-30 PSU (Dry Season) and 5-15 PSU (Wet Season)
	Ridge-Slough-Tree Island Landscape Pattern	Hot Spot Vegetation Mapping	N/A	Every 3 Years (Total = $75,000)	$25,000	NW-WCA3A, NE-WCA3A,WCA-3B, NE-SRS	a) Daily, seasonal, annual hydroperiods (EDEN. SFWMD, ENP). b) Water Distribution (EDEN, SFWMD, ENP). c) Wetland Vegetation Mapping (RECOVER/MAP)	Veg. Mapping in ENP	$250,000	Ridge & Slough Landscape Pattern Target (MAP)	Tree Island Increase Areal extend
	Mangrove Migration Rate (White-Zone)	Hot Spot Vegetation Mapping	N/A	Every 3 Years (Total = $75,000)	$25,000	ENP Shark River and Taylor River (White Zone)		No On-going Monitoring		Mangrove productivity and growth	Mangrove expansion reduction by 5 %
	Forest Structure and species composition	4 Permanent Plots and 3 Transects per site	Ten Tree islands and 3 Mangrove Forests	Same Tree Islands and plots Every 5 Years	$70,000	NW-WCA3A, NE-WCA3A,Central WCA-3A,WCA-3B, NE-SRS, ENP Mangrove Forests		Tree Island Condition in Southern Everglades	$97,300	Forest structure and plant diversity	Tree Island Increase Areal Extend
	Biological Indicators: Algal Blooms	Grab samples with picment analysis	12 sites nearshore embayments and lakes	monthly	$60,000	Dowstream of SRS, Taylor Slough	Bimonthly SFWMD coastal Monitoring	No On-going Monitoring	$0	Algal Bloom Stoplight Indicator	No Algal Blooms
	Biological Indicator: Cattail Expansion		N/A				RECOVER-MAP	Mid-Shark Slough Monitoring On-going	$64,000		No specific target yet
	Biological Indicator: Pink Shrimp and epifauna	Throw traps in association with FHPAP SAV monitoring	N/A	Wet and dry season	$80,000	Whitewater Bay, Whipray Basin, nearshore central Florida Bay			$0	Juvenile Pink Shrimp Stoplight Indicator, Interim Goals Indicator	Semi-annual Density 5-17 m^{-2}

Continued on next page.

C

CEPP Objective	CEPP Monitoring attributes	Monitoring Methodology	Number of Transects / sampling points	Monitoring Frequency	Estimated Annual Cost	Specific CEPP Monitoring Locations	Current Monitoring (OTHER)	Current Monitoring (RECOVER/CERP)	Current Monitoring Annual Cost (RECOVER/CERP)	Performance Measures / Ecological Indicators	Monitoring Targets
Reduce high volume discharges from Lake Ockeechobee to improve the quality of oyster and SAV habitat in the Northern Estuaries	SAV shoot count, density, and canopy cover and height	1 m^2 Quadrants	30 points per site	bi-monthly		Caloosahatchee River Estuary, St. Lucie Estuary,	a) Daily, seasonal, annual hydroperiods (EDEN. SFWMD, ENP). b) Water Distribution (EDEN, SFWMD, ENP). c) Wetland Vegetation Mapping (RECOVER/MAP)	West and East Coast Oysters	$250,000	SAV and Oyster Indicators	No specific target yet
	Shoot count, density, and cannopy cover and height of Vallisneria sp	1 m^2 Quadrants	30 points per site	bi-monthly		Caloosahatchee River Estuary, St. Lucie Estuary,		West and East Coast Oysters			
	SAV, Vallisneria, and Oysters beds Mapping	Mapping		Every 5 Years		Caloosahatchee River Estuary, St. Lucie Estuary,					

D

CEPP Objective	CEPP Monitoring attributes	Monitoring Methodology	Number of Throws per sampling Units	Monitoring Frequency	Estimated Annual Cost	Specific CEPP Monitoring Locations	Current Monitoring (OTHER)	Current Monitoring (RECOVER/CERP)	Current Monitoring Annual Cost (RECOVER/CERP)	Performance Measures/Ecological Indicators	Monitoring Targets
Reduce water loss out of the natural system to promote appropriate dry season recession rates for wildlife utilization	Dry Season Prey Availability	1-m^2 Throw traps		Dry season		NW-WCA3A, NE-WCA3A,Blue-Shanty Flow-way, WCA-3B, SRS, ENP	a) Daily, seasonal, annual hydroperiods (EDEN. SFWMD, ENP). b) Water Distribution (EDEN, SFWMD, ENP). c) Wetland Vegetation Mapping (RECOVER/MAP)	Dry Season aquatic Fauna	$213,000	Fish and Macroinvertebrate Stoplight Indicator	Droughts events at higher than 3-8 years intervals
	Wet Season Prey Production	1-m^2 Throw traps		Wet season		NW-WCA3A, NE-WCA3A,Blue-Shanty Flow-way, WCA-3B, SRS, ENP		Wet Season Trophic Sampling	$316,000		
	Mangrove zone prey base production (Fish and Spoonbills)	9-m^2 drop-nets within sampling units	9 Drop-nets per sampling unit (12 sites)	Early Dry Season, Late Dry Season, and Wet Season	$60,000	Cape Sable, SRS and Taylor Slough	Audubon prey base monitoring in eastern Taylor Slough (C-111 Spreader Canal Project)	Audubon prey base monitoring in southeast Evergalades	$200,000	Spoonbill Stoplight Indicator	Achieve nesting succes in 7 out of every 10 years

E

CEPP Objective	CEPP Monitoring attributes	Monitoring Methodology	Number of Transects per CEPP Location	Monitoring Frequency	Estimated Annual Cost	Specific CEPP Monitoring Locations	Current Monitoring (OTHER)	Current Monitoring (RECOVER/CERP)	Current Monitoring Annual Cost (RECOVER/CERP)	Performance Measures/Ecological Indicators	Monitoring Targets
Restore more natural water level responses to rainfall to promote plant and animal diversity and habitat function	Alligator-Crocodiles Density	Spotlight and capture surveys		Dry and Wet seasons	$80,000	SRS, ENP	a) Daily, seasonal, annual hydroperiods (EDEN. SFWMD, ENP). b) Water Distribution (EDEN, SFWMD, ENP). c) Wetland Vegetation Mapping (RECOVER/MAP) d) Crocodiles and wading bird monitoring in ENP (timing/location/success/# for bird spp) e) Monitoring Alligator nest in ENP	No On-going RECOVER Monitoring	$0	Crocodilian Stoplight Indicator	Count Density >1.7 Body Condition 2.11-2.27
	Adult Alligator-Crocodiles body condition	Capture surveys		Dry season				No On-going RECOVER Monitoring	$0		
	Juvenile crocodile growth and survivorship	Time series measurements of individuals		spring-summer	$55,000	Fl Bay: Cape Sable to Highway Creek		No On-going RECOVER Monitoring	$0		
	Number of nesting birds and species	aerial and ground surveys.		Monthly during the Breeding Season	$80,000	NW-WCA3A, NE-WCA3A,Blue-Shanty Flow-way, WCA-3B, SRS, ENP		Wading Birds (UF-USGS-FAU-Audubon). Monitoring includes LO, WCA's, ENP, BB, Florida Bay	$500,000	Wading Bird Stoplight Indicator	4,000 of nesting bird pairs of Great Egreats; 3,000 pairs of Wood Stork; 10,000 pairs of white ibis
	Timing of Bird Nesting	aerial transects and ground surveys.		Monthly during the Breeding Season							
	Location and Distribution of Bird nesting sites	aerial transectsand ground surveys.		Monthly during the Breeding Season							
	Bird Nesting Success	aerial transects and ground surveys.		Monthly during the Breeding Season							

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